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OF THE

QUARTERLY JOURNAL OF SCIENCE,

INTO WHICH THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL

IS NOW MERGED.

JANUARY, 1865.

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NOTICE TO READERS.

The Editors will be glad to receive the printed Reports of all Scientific Societies (Metropolitan or Provincial), including those of Schools and Classes of Science, and of Naturalists' Field Clubs. Also Scientific Addresses, Reports, and Lectures.

Manuscript sent for approval must be accompanied with sufficient stamps to cover the return postage in case it should be deemed unsuitable. Observers in all branches of Science are invited to communicate briefly their new observations, but copies of these must be kept by Authors, as they cannot be returned if not considered suitable to the pages of this Journal.

Contributors are alone responsible for their opinions on Scientific subjects. The desire to publish both sides of a debated theory may often necessitate the insertion of views at variance with those of the Editors.

No notice whatever will be taken of anonymous communications.

THE QUARTERLY

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JANUARY, 1865.

ORIGINAL ARTICLES.

THE SCIENCE AND ART DEPARTMENT.

In the Introduction to this Journal we announced, as a portion of our programme, the discussion of Scientific questions allied to politics,* and we referred more especially to the action of the Department of Science and Art in promoting Science instruction throughout Great Britain.

This intention we have hitherto fulfilled only so far as to publish on two occasions the lists of gold medallists at the State Examinations; but in our last Number we promised to devote a portion of our space to the consideration of the whole subject, and that we now propose to carry out with strict impartiality. The last observation is rendered necessary by the fact, that the criticisms with which we shall feel it our duty to accompany a brief review of the history of the South Kensington Science movement, will not be of the most flattering kind, so far as they concern those persons who have directed the scheme during the last three or four years; but the only personal feeling we have in the matter, is one of regret, that a movement which we have endeavoured earnestly, though humbly, to promote by word and deed, should present so unfavourable a retrospect, and be marked by such grave acts of injustice as those by which we shall find it to be characterized. Inviting our readers, more especially the uninitiated, to follow with us the history of the scheme from its commencement, we find that in the year 1859, only five years since, the Committee of Council on Education, of which Lord Salisbury was then the President, offered to professional men who had been favoured with a scientific education, a moderate but honourable remuneration, to induce them to enlist in the service of the State, for the purpose of extending the usefulness of the Science and Art Department; and they further sought to secure for their excellent project the honorary aid of persons throughout the length and breadth of the land, who, from purely disinterested motives

* 'Quarterly Journal of Science,' vol. i. pp. 21, 22.

desired to promote the cause of Science, and to raise the intelligence of the industrial classes. The former were to act as Science teachers, the latter as committees of management under the guidance of the State.

Industrious and self-denying men of Science were told that if they would qualify themselves by the requisite studies, and by passing an examination that would entitle them to become certificated teachers, they would receive, *whilst actually engaged in* "*giving instruction in a school or Science class for the industrial classes, approved by the Department,*" "*annual grants,*" according to the grade of their certificates.

"For the 1st grade of competency	- -	20*l.*
" 2nd " "	- -	15*l.*
" 3rd " "	- -	10*l.*"*

And these sums were to be paid without reference to the small fees which they might receive from their students.

The State further told them, that in order to assist them in raising their students to the highest state of proficiency, it would give to the latter prizes and medals; and that payments would be made to the teacher, "on each first class Queen's Prize obtained by the student, 3*l.*; on each second class, 2*l.*; and on each third class, 1*l.*" †

To gentlemen who had the leisure and inclination to co-operate with them through the formation of schools or Science classes, my Lords said, if you will apply to us through your managers "*for a certificated teacher,*" or for the certification of any teacher, we will provide you therewith.‡

Admirable was the operation of this "minute." Annual examinations were held at South Kensington, to which scientific men hastened to take their degrees; some with a view to take office under "the Department," others to make themselves acquainted with the routine practised by the Committee of Council on Education, and thus the more effectively to give their aid as honorary promoters of Science classes.

There can be no mistake concerning the intention of the State when this scheme was set on foot, and whoever reads carefully the wording of the regulations in the Report referred to, will be satisfied that it was meant to convey the impression that those who entered its service would be remunerated by annual payments of the amounts specified, so long as they were engaged in teaching under the Department; and neither teachers nor members of committees could for an instant suppose that these payments would be rapidly diminished, and that the State would speedily shake off its responsibilities and leave them to shift for themselves.

But this, we shall find to have been the case.

At first it was found a very difficult matter to set the machinery at work, and the most creditable efforts were made by the Department to establish classes throughout Great Britain.

Earl Granville, who followed Lord Salisbury as President of the

* 'Sixth Report of the Science and Art Department, 1859.'
† Ibid. ‡ Ibid.

Committee of Council on Education, took a deep personal interest in the movement, and visited some of the provincial towns, where efforts were being made to establish schools. But even at this early stage of the proceedings, there were indications that the movement was not to be characterized by that high tone of morality, by that scrupulous honour, which should distinguish all philanthropic schemes, more especially such as are undertaken by the State.

In their efforts to establish classes, the heads of the Department sometimes pushed their zeal beyond the limits of discretion. The lectures delivered by the officials, as, for example, that of Captain Donelly, the Science Inspector, which was read on the 4th February, 1861, at South Kensington, and was afterwards published along with several others by the examiners, were all well adapted to secure the desired end; although, in reference to Captain Donelly's lecture, we cannot help remarking, that it sounded the first note of disavowal, and was calculated to shake the confidence of those who read it, in the *bonâ fide* intentions of Government. But in the selection of its emissaries to the provinces, the Department was by no means so happy as in that of its metropolitan advocates; and a certain Mr. Buckmaster, who called himself the "organizing teacher," but whose name will not be found in any of the printed lists of officials attached to the "Directories," was the chief instrument employed for the establishment of new classes. This gentleman, who possesses a high degree of energy combined with an equally large amount of volubility, succeeded by the promises which he held out on behalf of the State in promoting the establishment of several new classes. We have heard it said, however, that the Department could not always recognize the validity of these promises, as some of them were not in strict accordance with its regulations; and although complaints were made to the highest authorities, this gentleman was subsequently retained by the Department, "unattached," it is true, and has been rewarded for his services in a somewhat equivocal manner, to be described hereafter.

The result of the efforts made by the Department to establish classes—the impetus given by the first swing of the pendulum—has been astonishing; and notwithstanding the serious drawbacks which followed, we find this result to be represented by the following data:—

In the year 1859, the classes were five in number; in 1864, ninety-five. In the Report of 1859 we find mention made of five students who had taken certificates as Science teachers; in 1864, the list of certificated teachers comprises 332 names, some being of men of the highest standing and intelligence; and whilst we find no record of the number of students taught in the five schools which were in existence in 1859, the number of those who attended the 95 classes of 1864 was 3,560.

But we must review cursorily the action of the State in the interim, and we fear that some features will present themselves which will tend materially to qualify the admiration wherewith every one must regard this effort to improve the intelligence of the industrial classes.

Every year, since the publication of the Sixth Report, a 'Directory' containing revised regulations has been issued by the Science and Art Department, and in that of 1860 (the minute of 1859 not having as yet produced the desired effect), the questions of certificate money, Queen's prizes, and all other matters of a similar character, were allowed to remain unchanged; early in 1861, however, appeared Captain Donelly's lecture, in which the Department of Science and Art was declared to be "now the constituted machinery for giving State aid to certain branches of instruction;" but a gentle hint was given to those whom it might concern, that whilst the Government would grant such aid with as little interference as possible, yet it *might* hereafter reduce or eventually withdraw the stipends of teachers. This announcement was accompanied by appeals to the patriotism and *amour propre* of committees to make the movement self-supporting, so that it might require less and less "cockering up by State aid."

The fact is, that a contest for the loaves and fishes had begun between the Science and Art Department and the Education Department of Whitehall, the latter being represented by Mr. Lingen, who, jealous of what appeared to be the preference shown to Science instructors, after the screw had been adjusted all over the country in National schools, showed his appreciation of high mental acquirements, by manifesting a desire to see Masters of Arts of Oxford and M.D.'s of London, who might be engaged at the invitation of Government in teaching Natural Science to artisans for 20*l.* or 40*l.* per annum, placed on the same footing with village instructors in spelling and the first rules of arithmetic.

In fact, these gentlemen must no longer be paid according to the rank of their attainments, but, as in the other case, "upon results." We shall see presently how far *that* system (the system of results) was adhered to; but meanwhile we must mention, that the Department of Science and Art was powerless to resist the encroachment, and, although it consoled itself with having gained the questionable advantage previously denied to it, of granting aid to certificated teachers in elementary schools, who felt disposed to give their services as Science teachers, we find in a second revised 'Directory' issued in 1862 (for there were two 'Directories' published in that year), that all the previous conditions upon which the teachers had been engaged were annulled, and their payments were to be regulated solely by the number and proficiency of passed students.

Thus, it mattered not whether the teacher was a lecturer of high scientific attainments to whom a "diploma,"* or a first grade certificate, had been granted, or whether he was a teacher in a village school who had managed to obtain a certificate of the lowest grade.

When we have followed the history of the movement a little further, we shall find, that if we were at first disposed to accredit the Government with the sole desire to benefit the "industrial classes" by this change, such an opinion will be untenable, for these have been treated with the same parsimony as their teachers.

* In a few cases diplomas were granted to men of well-known attainments, without examination.

The fact is, the State had undertaken too much, and had not the moral courage to restrict its operations. The 'Directory' of 1862 contained a list of 171 certificated Science teachers against 53 in 1860, and whilst the Government seemed indisposed to increase its expenditure by an additional outlay "in aid," it still permitted their number to increase without limitation. But, in the same 'Directory' we first find the unmistakable announcement (three years after the movement had been started, and one year after it was fairly in operation), that the amount of remuneration to teachers "is liable to be decreased, and altogether withdrawn."

It might perhaps have been pardonable in the State if it had said to the crowds who were flocking in to enlist in its service, "Come, gentlemen, without let or hindrance, and join in our work, we don't mean to pay you much longer, so, the more the merrier, and you may, with the help of your committees continue the work we have so gloriously begun." But was this honourable to those who were already engaged in teaching, or to the committees whose gratuitous services had been secured on the conditions previously announced? We think not; and we think too, that the Government which has so acted, will find that its proceedings have not been dictated by a sound policy.

The state of affairs under the new régime, then, was as follows:—Instead of being paid a fixed stipend varying in value according to the grade of his certificate, &c., the teacher received a grant composed of head moneys—say, for every "passed" student, 1*l.*; for "honourable mentions," 2*l.*; and for 1st, 2nd, and 3rd grade prizemen, 5*l.*, 4*l.*, and 3*l.* respectively.

So far there was not much to be complained of in the change; and it is only fair to Government to say that, on the whole, it appeared to have been dictated by justice and prudence; for if, under the old regulations, a teacher held six first-class certificates in six distinct branches of Science, he could claim 20*l.* upon *each* of those certificates, if he was teaching thirty students in any *one* branch of Science only;* but if he held *one* certificate only, and was teaching 100, or any other number of students, in the branch for which it was given, he could still only obtain 20*l.* on his certificate besides his prize-money, should his students have been successful in obtaining prizes.

Under the new regulations, however, the teacher received the sums above mentioned for *every* passed student, "honourable mention," or prizeman, *without* limit as to number. But then a provision was added, that 5*l.* would be the maximum amount paid upon any one student; and (to cut a long story short) in the 'Directories' of 1863 and 1864, new minutes were issued, which, without any justification or show of reason, reduced the stipends of the teachers apparently in the inverse ratio to their proficiency!

Thus, "If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in

* The regulation being that he should be paid 4*l.* per head for every student under tuition, up to the maximum value of each certificate held by him.

respect of such further subject in which he is successful" ('Directory' of 1864, Rule xix.); and again, "Payments are only made on the foregoing scale when they amount to not more than 60*l.*; when on this scale they would amount to more than 60*l.*, the excess up to 40*l.* is diminished by one quarter; the excess above 40*l.* by one-half." (Ibid., Rule xx.) And not only were the emoluments of the teachers cut down, but their duties were increased to an unnecessary degree, the State requiring them in some instances to perform herculanean feats of intelleet. In fact, the object of all these changes was sufficiently obvious; it was to increase the labour and diminish the emoluments of the teacher to such a degree as to compel him to dispense with the State aid altogether.

We will give one or two illustrations of the operation of these minutes, and of the wisdom and justice by which they were dictated. Let us suppose that in 1860 a first-grade teacher was imparting instruction in one subject to five pupils, of whom three gained first-class and two second-class prizes; he would receive from the State 20*l.* (4*l.* per head) on his certificate, and 13*l.* prize-money; and suppose that, continuing to teach the same class in 1861, the three first-class prizemen again took first-class prizes and medals in addition, and that the two second-class men improved the grade of their prizes, he would receive no remuneration on the medallists, but still 20*l.* on his certificate and 15*l.* prize money=35*l.*, an advance of 2*l.* for the increased proficiency of his pupils; being in all a sum of 68*l.* for delivering 80 lectures at least to his class in two years.

But now, let us suppose the same teacher to be at work in 1863 and 1864 under precisely the same conditions, and under the revised code, and what would be the result?

In 1863 he would receive no "certificate" money, but 23*l.* on "results," and in 1864, when his five pupils had increased in proficiency in the degree named above, he would receive *nothing* upon his three best pupils who had taken medals, and 2*l.* upon the two who had risen in the scale of prizemen! In short, he would have delivered at least 80 lectures in two years, and instead of the moderate sum of 68*l.* under the old regulations, he would receive the munificent sum of 25*l.* (23*l.* the first year, and 2*l.* the second) for imparting Science instruction to those "who are unable to help themselves!"

But it may be thought that we have selected or supposed the worst possible case to illustrate the operation of the new minutes. This is not the fact; there are worse cases actually in existence. When the Liverpool school was first started in 1861, it supported two lecturers, one gentleman being one of the most successful teachers that had been called into existence by the Department, and the other a medical man, of high scientific and literary attainments, and a graduate of Oxford University. The number of regular students in the school was about 130; and for imparting instruction to these, the Government grant amounted to about 140*l.* or 150*l.* In 1864 the school had materially extended its operations, and possessed two teachers in addition to those referred to; the number of students remained about the same (125), but these had attained a much greater degree of profi-

ciency, some of them having taken high honours in five or six branches of Science.

What does the reader suppose was the amount paid "in aid" to its four lecturers? About 40*l.* or 50*l.* *in all*, with the prospect of that sum being still further reduced, provided the committee should comply with the difficult conditions of the State, and nothing at all if they failed to do so! *

What would our ministers of State and heads of Departments say, if we, the tax-payers of the country, treated them after such a fashion?

It is true that they can point to the figures in their Blue Books and show that they have raised up a vast and useful system of scientific education, without any material increase in the national expenditure; but even those figures will not bear a close investigation.

We find entered in the Report of the Department for 1859 the following items of expenditure:

	£
In aid of teachers of *all kinds* (Art as well as Science) about	15,400
For general management	3,600
Under the head of South Kensington Museum	2,350
In the Blue Book of the year 1864, with its addition of about 330 teachers and 3,500 students, we find the following payments in aid, to *all* teachers as before, about . .	16,500
(or an increase of about 1,000*l.* in six years.)	
"General management"	5,000
(or an increase of about 1,300*l.* in the same time.)	
"South Kensington Museum"	4,200
(or an increase of 1,900*l.*)	

Thus, the salaries of the South Kensington officials had been raised by a sum rather more than the total amount of increase "in aid" of the 300 additional teachers. And besides this, we have the modest little sum of 11,473*l.* 18*s.* 9*d.* (equal to about two-thirds of the total grant "in aid") put down to "Objects purchased for National Art Museum," which we presume to mean, Mr. Cole's hobby at South Kensington!

Again we would ask whether this is fair to the large body of Science teachers?

Why should the salaries of the secretary, and all other officials, increase at the rate of from 40*l.* down to 10*l.* per annum,† and at the same time the stipends of the teachers, who are doing the real *work* of the Department, be materially diminished year by year, and at last entirely confiscated?

We say nothing of the binding nature of the engagement under which teachers were first enlisted, but as taxpayers and men of busi-

* This session—1864-5—the school has with difficulty been started, owing to the mode in which the State has treated the lecturers. The necessarily increased fees of students, have materially diminished their number.

† See 'Civil Service Estimates (Education, Science, and Art).' 1863.

siness, we cannot quietly acquiesce in this mode of distributing the public funds.

And if the teachers have thus fared at the hands of the State, have the students had better justice dealt out to them?

In seeking the reply to this inquiry, we have to consider elements very different from those which affected the interests of the teachers; but even here, so far as the State management is concerned, it leaves much to be desired.

Some credit is due, and has been conscientiously acknowledged by the State, to the Committees who have co-operated with it in the establishment and maintenance of the various schools and classes which have so suddenly sprung into existence, but their chief merit has consisted in the perseverance with which they have endeavoured to maintain the integrity of the institutions, and honourably to fulfil *their* duty towards both teachers and students in the face of the rapidly diminishing State aid, and increasing State interference.

There is no doubt, however, that for the real, lasting benefits which have been conferred upon students, the latter are mainly indebted to their devoted teachers, who, notwithstanding the inconstancy of the State, have never for an instant relaxed their efforts to raise the intelligence of the "Industrial classes." No money payment could adequately compensate the teachers for their services; but we can assure them, after a careful study of the relations existing between them and their pupils, that they have earned the deepest gratitude, and are in possession of the best wishes of those for whom they have laboured so assiduously. To this fact many letters, as well as spoken words, have testified, and it is truly the green spot in this dreary history.

As to the State, it has granted, and still continues to distribute, amongst the students what are called "Queen's Prizes" and Medals. The former are books, and the latter very beautiful medals of gold, silver, and bronze.

The number of books (Queen's Prizes) awarded to each successful student, was from the first judiciously limited, but the binding of those which represented one or more prizes of the first grade was rich and elegant.

Fiscal economy soon, however, dictated unsatisfactory changes even in this paltry matter. The bindings became less attractive, the number of books awarded to each successful student was reduced, and an attempt was made to do away with the second and third grade prizes altogether. The last-named minute was rescinded, owing to the opposition which was raised against it, not, however, without a slight turn being given to the screw in another direction. Some idea may be obtained of the diminished number and value of the prizes from the fact that in 1861–2, the *estimate* for prizes, medals, &c., in Art and Science, was 2,750*l.*; and for 1862–3, 3,000*l.*;* whilst in the return made in 1864, with the vast addition of students that had taken place, the item for all kinds of prizes in Art and Science, is 2,503*l.*

* See 'Education Estimates for 1863.'

But this is not the worst feature in the affair. There is a matter to which the attention of those who are the nominal heads of this Department cannot, we think, have been directed, or we feel confident it would never have been tolerated.

Whatever might be the number of books distributed, or their external appearance, at least it was to be expected that all the works on the list from which students are permitted to make their selection, would be of an unimpeachable standard; that all the prizes indeed would be worthy of the exalted Personage whose gift they are supposed to be.

A cursory glance at the list will, however, satisfy any unprejudiced person that there have been in its compilation considerations other than that of providing successful students with standard works on Science; and we really think that the State did not exercise a sound discretion, nor add to the respect which, it is no doubt desirable, should be entertained for it by young students of Science, when it offered them as a reward for successful study the valuable contributions to our scientific literature of the still "unattached" Mr. Buckmaster. As we have already said, the energy of Mr. Buckmaster has doubtless been of great value to the Department, and the results of his persuasive eloquence are no doubt deserving of an appropriate reward; but the insertion of his little books in the State list is, we venture to think, a very *in*appropriate method of crowning his labours, and it has caused great chagrin in those quarters where, through misplaced confidence, they were selected as prizes; nor has the student any alternative but to select these works in case he takes a low prize and wishes for a book on the subject of which they treat.

Had the section in which they are comprised consisted entirely of such productions, we might have been led to suppose that the Department had taken a leaf out of the book of some of our less liberal Railway Companies, which compel their passengers to ride second-class by making the third as uncomfortable as possible; but when we find in the same group with 'Buckmaster's Elements of Chemistry,' Professor Ramsay's 'Lectures on Physical Geography,' and works of a similar kind, we cannot help feeling that the introduction of the former in the list is attributable to motives which ought not to influence those under whose direction this portion of the public service is conducted. We direct attention more especially to this case, as being one which we think must have escaped the notice of the head of the Department, but there are other "Queen's Prizes," which are open to objection, and no doubt an inspection of them in the proper quarter would lead to beneficial changes in the list.

The mention of Professor Ramsay's name will probably have reminded some of our readers that there is a small body of gentlemen connected with this Department of the State, without a reference to whom, our notice would be very incomplete; we mean the "Professional Examiners for Science."

In the selection of these, the State has exercised great judgment; and this portion of the work of Science instruction is being carried out on the most approved principles. We have from time to time had

occasion in company with able teachers of Science, to peruse the examination papers of several of these gentlemen, and can fully indorse the opinion we have often heard expressed that the whole heart of the examiners is in their work.

Because these gentlemen are moderately remunerated, it does not follow that the students and votaries of Science are under no further obligation to them, and we do not feel it to be a presumption on our part, when, in the name of all interested in the diffusion of sound scientific information, of students, teachers, and committees, we say that they are entitled to our cordial thanks, and to our best wishes. We trust that they may long continue to direct the examinations in their respective departments of Science. Professor Huxley on Zoology; Dr. Lankester, Botany; Professor Ramsay, Geology; Professor W. W. Smyth, Mineralogy; Professor Hoffmann, Chemistry; Professor Tyndall and the Reverend B. M. Cowie, Physics; and Professor Bradley, Geometrical Drawing.

Quitting now the bright side of our subject, we must return for a moment to the question of the teachers' grievances. And it may possibly appear strange to some of those who have followed us in this cursory and imperfect review of the South Kensington Science movement, that if the reductions, which have been made from year to year in their emoluments, had been considered unfair by the masters, they would have broken out into open opposition.

"How is it," they may be inclined to inquire, "that these 'minutes,' have been issued year by year without any *public* protest against their injustice?" For whoever has conversed with teachers and committees, knows well that, privately, much dissatisfaction has been expressed, and that representations to that effect which have remained unheeded, have even been made through the proper channels to the Department.

The reply will be found in the following story, which, though very old, has lost none of its force when applied to the case under consideration.

There once reigned, somewhere in the East, a great tyrant, who, like the Caliph Haroun al Raschid, used to amuse himself by walking abroad alone to hear what people said of his rule.

This bad ruler, having heard of a poor defenceless old woman who possessed four cows, sent down one of his minions to take away one of them, and transfer it to the "Crown." A few days afterwards, when the king was passing the poor woman's cottage in disguise, he heard her, in her devotions, secretly invoking curses on his royal head, and praying for his speedy removal to a better land.

Thereupon he sent an officer to take away another of her cows; and on again passing the cottage shortly afterwards, he heard the old woman reiterate her prayers to the Almighty to punish and remove the tyrant who thus plundered his subjects. The result was, as may be anticipated, the disappearance of a third cow; but when some time afterwards his Majesty was passing by the cottage, he heard, to his astonishment, a voice praying for his long life and unimpaired health. On entering the cottage he was surprised to find a poor decrepit old

creature lying helpless upon her couch, and when he asked her why she offered up such prayers for a tyrant who had deprived her one by one of her most valuable possessions, she told him that after each act of spoliation, she had secretly invoked curses on his head, but that, finding the sole result to be the abstraction of some of her remaining property, she had now changed the tenour of her prayer . . . lest he should rob her of her last cow! It is so long since we read this story that we forget whether the tyrant, whose better instincts prevailed for a season, returned the poor woman her cows, of which she had been plundered, or whether he was content to leave her in the possession of her sole remaining property; but, proceeding to the application of our story, we feel sure that unless the Science teachers of the country bestir themselves manfully they will not be left long in the undisputed possession of *their* last cow.

Like the tyrant in the tale, that section of the State which ought to exercise a paternal influence, and watch over the interests of Science and Art, is far from evoking the *blessings* of the community, and no doubt its faithlessness has often caused, and must still continue to give rise to much secret distress, which the helplessness of the sufferers has compelled them to bear without a murmur.

The question, "Who is responsible for these grievous wrongs?" may be easily answered by any one who has carefully watched the progress of events, and the reply is aptly conveyed in the words of a recent French writer on Social Reform,* who says—"A matter which, in the infancy of the system, would have been managed by the Prime Minister himself—which, in the growth of its intricacy, would have been entrusted to a 'Director-General,' to a 'Director,' to a 'Chef-de-division,' to a 'Chef-de-bureau'—is now only understood in all its details by a 'sous-chef,' whom such petitioners as happen to be well directed manage to find in huge barracks of bureaucracy in Continental capitals. It is this 'sous-chef' who, in the now existing state of things, draws up whole batches of 'minutes,' *which even the most painstaking ministers must often sign unread.*"

Let the reader shift the scene from Paris, or Berlin, to Whitehall and South Kensington, and he will understand the secret of all that mismanagement which has called forth such loud and oft-repeated complaints.

The most anomalous feature in the whole affair, however, is that a glance at the past history of this Science movement serves to show that it was begun in a *liberal* spirit by a Conservative Ministry, but was continued in a spirit neither conservative nor by any means liberal, by a "Liberal" Ministry.

It may, perhaps, be suspected that in pointing out this circumstance, we have some political motive, beside the real question at issue; but this is, most assuredly, not the case. The circumstance has been brought under our notice by persons to whom we have complained of the course adopted by the State, and the reply (suggested, no doubt, by party feelings) has often been—"Yes, it is

* 'La Réforme Sociale en France,' &c. Par M. Le Fay.

very wrong, and you will have no redress until we have a new Ministry."

We do not mean to seek notoriety, nor to curry favour with any "party," by an attack upon the existing Government; neither is it our intention to denounce that Department of it which has so completely belied the great principles of the Liberal party. The former would be to us a distasteful proceeding, and the latter, which has often been effected with scathing sarcasm, would simply be injurious, and of no avail towards securing the end we desire—namely, *justice.*

Instead of reaping a reward for the freedom with which we have commented upon the shortcomings of one section of the State, we must even be prepared to incur a considerable share of ill-will, and to lose some friendships. But, however we may have to deplore the one, or to miss the other, we shall be well satisfied to abide by the consequences, if the mischief which has been done be but speedily repaired. The plea of "economy," in justification of the course that has been adopted, is a wretched one; and we express and endorse the opinion of one of the leading financial reformers of the day, in stating that the very last item of the national expenditure which the people of this country would desire to see curtailed, is the unimportant one which provides for the intellectual improvement of the masses.*

As it is, however, not safe to be too sanguine, and to expect that the State will voluntarily retrace its steps, we must, as an alternative, address a few words of counsel to the Science teachers of the country. Their strength, and perhaps their only hope of redress, lies in concert and agitation, those two talismans which have so often wrought wonders upon obdurate rulers, and it has frequently been a matter of surprise to us that they have sat still, and looked on patiently, whilst acts of injustice have been committed, without making any attempt to form themselves into a protective Association. The rapid modes of intercommunication which now exist would render such a scheme easy of accomplishment, and the delegates from various districts in the United Kingdom could easily hold an annual Conference, which might not only consider the best means of guarding the interests of the teachers, but of promoting the work of Science instruction.

If the more prominent and influential teachers choose to bestir themselves, and to prevent the body from remaining any longer a bundle of loose fagots without bond or tie, they will no doubt find many who are willing and ready to give them material and moral support (should this be requisite), and gentlemen of influence in Parliament willing to represent their interests.

But, to be effective, such a movement should not be long delayed. A dissolution of Parliament cannot be far distant, and besides the value, at such a juncture, of an associated body prepared to act as a whole, it would no doubt be found that many of its individual mem-

* In the year 1861-2, when this scheme of Science Instruction may be said to have been in active operation, the total amount of money expended on 'Education, Science, and Art,' was 1,359,996*l.*, of which 'Science and Art' received 111,484*l.*, and of this latter sum, the amount devoted to Science and Art *tuition* (salaries and payments in aid), was 17,500*l.*! and for rewards to students 2,750*l.*

J. Wolf. del. et lith. M & N. Hanhart imp

TYPICAL MAMMALS OF AUSTRALIA

bers would be well able to wield the pen, and might exercise considerable influence upon Constituencies. For the present, then, we reserve further comments, but when the proper time arrives, our aid will not be found wanting, and if it be required, the little influence we possess will be at the service of those whose interests these remarks are intended to protect, and with whose labours in the cause of Science we have the most sincere sympathy.

THE MAMMALS OF AUSTRALIA.

By P. L. SCLATER, M.A., Ph.D., F.R.S., Secretary to the Zoological Society of London.

THE remains of extinct organisms have long since been adopted by geologists as the only sure guide to the age of the strata in which they are entombed. However dissimilar two formations may be in other points, it is now universally acknowledged that, if they furnish the same fossils, they must be considered as of the same period of deposition. However much two formations may resemble each other in composition, it is quite certain, if their fossils differ, that they must be attributed to different geological epochs. Concerning the origin of life upon this planet we can say nothing. But as to its progress, we now know that from the remotest time to which we have yet traced it back to the present moment, it has gone on in one constantly-flowing but ever-varying stream, slowly yet surely changing its aspect as it moves forward, and never returning at any subsequent period to the same appearance as that which it has before presented. The further it advances, the greater is the amount of variation. The present Flora and Fauna of the earth is more like that of the tertiary period than that of the secondary, and the further we go back into primeval time, the greater divergence we find in the aspect of the animal and vegetable kingdoms. Thus it follows that the amount of difference between the organic life of two successive epochs becomes a measure of past time, and since the antiquated notion of an indefinite number of separate creations has been discarded and the great fact of the *unity* of organic nature acknowledged, it has been generally recognized as such by all true philosophers.

But it is not only the whole stream of life upon the globe that is perpetually altering its general appearance; each branch of it, as it diverges from the parent stream, acquires an individuality of its own, and becomes more different the longer it is separated from the main channel. Upon re-entering this it again mixes with the general current, and gradually loses the destructive features it has previously acquired. This seems to have been the case with the Fauna of Australia. Australia, judging from our present confessedly very imperfect knowledge of the history of its organic life, must have been separated from the great mass of land which forms the Old World at a time when Marsupialism was the prevalent, if not the only, form of

Mammalian life in existence upon our planet. During the ages which followed, the higher orders of the Mammalian series became developed in the great Paleogean Continent, while, for reasons which at present we cannot explain, Marsupialism remained permanent in Australia, and a varied series of herbivorous, insectivorous, and carnivorous Mammals, all united by the common link of this mode of reproduction, were developed in this isolated region. In comparatively recent times the water-strait between Australia and Asia again became narrowed, and placental forms of Mammals have thus penetrated into the former land of Marsupials.

It has thus, as I believe, come to pass that in Australia we find the Mammalian Fauna composed of two elements—the implacental and the placental; the Mammals of the former type being the old indigenous denizens of the country; the latter to be regarded as probably nothing more than intruders of comparatively recent introduction. Let us first consider the former and more characteristic portion of the Australian Mammal-fauna.

Beginning with the lowest Implacentals, we first meet at the outset with two forms of life so very different from the rest of their kindred, that they are now universally allowed to rank as a separate order, and by some of our most eminent authorities even as a distinct sub-class of the Mammalia. These are the extraordinary genera *Ornithorhynchus* and *Echidna*, which in their toothless jaws, in the conformation of the sternum and scapula, and especially in the structure of their reproductive organs, exhibit such unmistakable signs of divergence towards the class of birds, as to have acquired the name of *Ornithodelphia*. The *Ornithorhynchus* inhabits the South-eastern portion of the Australian continent and Tasmania. Of the genus *Echidna* two species are commonly recognized—*E. hystrix* of the southern parts of Australia, and *E. setosa* of Tasmania. These three animals are the sole existing representatives of the class Monotremata, and would of themselves be sufficient, even were all other signs absent, to stamp the region that they inhabit as a land of zoological marvels.

The second order of Implacental Mammals, although not absolutely restricted to Australia, since one distinct branch of it is purely American, constitutes perhaps a still more characteristic feature of its Fauna than even the Monotremes. At all events the Marsupials are so abundant in genera and species as to form by far the most prevalent portion of the Australian Mammal-fauna. While all the classes of Placental Mammals represented in Australia only furnish about 53 species belonging to 11 genera, upwards of 100 distinct species of Marsupials appertaining to 16 generic forms are already registered in our catalogues, and there is no doubt that in the little known districts of the north and west, others still await the researches of future explorers. Following the views of Mr. Waterhouse, I divide the Australian Marsupials into five families: the Macropodidæ, or Kangaroos; the Phascolomyidæ, or Wombats; the Phalangistidæ, or Phalangers; the Peramelidæ, or Bandicoots; and the Dasyuridæ, or Dasyures.

The Kangaroos or Macropodidæ must be considered as *par ex-*

cellence the most important group of the Australian Mammal-fauna. They are at once the most numerous in species, and in the former condition of Australia, before the influx of Europeans took place, were probably likewise the most prevalent form of Mammalian life as regards individuals. In his great work on the Mammals of Australia, Mr. Gould has devoted the whole of the second volume to the illustration of the members of this family, figuring no less than 44 species, and although some of these will be looked upon by most naturalists as rather in the light of local varieties than species, it is probable that the Australian Fauna embraces not less than 50 well-defined members of this beautiful group of animals. These are divisible into two genera—*Macropus* and *Hypsiprymnus*. The former genus contains the larger Kangaroos with the upper canines usually deciduous, when present, and the toes of the fore-feet nearly even; while *Hypsiprymnus* embraces the Kangaroo-Rats, as they are usually termed, which are all of smaller size, possess well-developed canines, and have the central toes of the fore-feet proportionately larger, so as to accommodate their digging habits. Of the true Kangaroos Mr. Gould has included 39 species in his above-mentioned work, while the Kangaroo-Rats are less numerous, some ten only of this group being at present known to Science.

The second family of Australian Marsupials—the Phascolomyidæ—are numerically of much less importance than the preceding, although the form and general appearance of the animals of the single known genus *Phascolomys* is hardly less *outré* than that of the Kangaroos. Until very recently but one species of this group was accurately known, although so long ago as in 1845, Professor Owen had characterized a second from the form of its skull. While further information is still required upon this species, a second very distinct form of the group, remarkable for its hairy muffle and pointed ears, has been received from South Australia,* and Mr. Gould figures two others—one of which may possibly be identical with Professor Owen's species. In general structure the Wombats are closely allied to the next family, the Phalangers—although their exclusively terrestrial habits naturally involve minor points of difference, which added to the somewhat trenchant characters presented by their dentition, have induced naturalists to recognize them as a separate family.

The Phalangistidæ, which next follow, are a much more extensively developed group of animals, presenting us with several well-marked generic forms, and nearly twenty readily distinguishable species in the Australian Mammal-fauna. While the Kangaroos are mostly grazing animals, and the Wombats burrowers and grubbers, the Phalangers are essentially arboreal in their habits and much more strictly nocturnal than the two former groups. In the daytime the Phalangers lie concealed in the hollow of trees, issuing forth at night to feed amongst the branches upon "leaves, buds, and fruits." The Koala or "Native Bear"(*Phascolarctos*), of which form a single isolated species only is known, serves to connect the Phalangers with the Wombats—being

* Phascolomys lasiorhinus, Gould, Mamm. of Austr., ii. pl. 59, 60.

allied to the latter by many characters, and amongst others by the absence of a tail, which distinguishes it from the rest of its family. In *Phalangista*, *Cuscus*, and *Dromicia*, the more typical forms of the Phalangistidæ, which next follow, the tail is not only well-developed but of vital importance to the animal, being used as a prehensile organ. The Flying Phalangers of the genera *Petarurus*, *Belideus*, and *Acrobates*, do not employ their caudal appendages in the same way. But this organ which is much elongated in all these groups, and densely clothed with hair, serves, along with the membrane extended between the fore and hind legs, in the manner of the Flying Squirrels (*Pteromys*), to support the animal in the air when descending from the top of one tree to the base of another. One more very singular little animal must be enumerated before we leave the Phalanger family—the *Tarsipes rostratus*—small in size but great in interest, even among the many abnormal forms of this wonderful land. The Tarsipes is of the size and general form of a mouse, but "with a long slender pointed muzzle," and the "nails of the toes for the most part embedded in the upper surface of the expanded fleshy pads with which they are terminated," thus affording some resemblance to the *Tarsius spectrum* of the Indian Archipelago, whence its name is derived. Another peculiarity of the *Tarsipes* is that its food appears to be exclusively honey—no other substance having been found in the stomachs of the specimens examined, and its long and slender tongue being obviously adapted, like the bill of the Humming-bird, and the brush-tongue of the Lories, for collecting such food.

The Peramelidæ or Bandicoots—the fourth family of Australian Marsupials—have teeth adapted to an insect diet, thus leading off towards the truly carnivorous group of Dasyuridæ, although we know from the records of trustworthy observers that some of the species feed more or less upon vegetable substances. Such is certainly the case with the *Perogalea lagotis*, or root-feeding Dalgyte, of Western Australia, which is abundant over the grassy plains of that colony, and from its burrowing habits and large hare-like ears, is commonly known as the "Native Rabbit." Of the typical genus *Perameles*, some six or seven forms are known, which are distributed all over Australia, each colony having its peculiar species. They are all purely terrestrial animals, some inhabiting the densest scrubs, and others the hot stony ridges of the upland plains. The only remaining member of the family is the anomalous *Chœropus castanotis*, which is confined to the hard stony grounds of the interior of the Southern colonies. Although agreeing in essential structure with the Peramelidæ, the *Chœropus* differs from its nearest allies, as well as from every other known Mammal, in its peculiar feet, on the fore-limbs only two toes being present, and on the hind limbs but one fully developed, and useful for locomotion.

The Dasyuridæ, which next follow, are the representatives of the Carnivora, in the Marsupial series, and as regards their largest and best developed forms are fully competent to take that place in the economy of Australian nature, which in most countries is filled by species of the genera *Canis* and *Felis*. Before, however, we mention

these predatory forms, a few words must be said about two genera, which although they belong to the same family are insectivorous, rather than carnivorous, both in habits and structure. One of them—the Banded *Myrmecobius*—constitutes another of those remarkable isolated types, which are so frequent in Australian zoology. The *Myrmecobius*, so called from its food being supposed to be ants, was first discovered in Western Australia, though it is said to have occurred also in the inner districts of the other Southern colonies. It is of about the same size as a common Squirrel (*Sciurus vulgaris*), and in the words of that accurate observer, the late Mr. Gilbert, appears very much like that animal, "when running on the ground, which it does in successive leaps, with its tail a little elevated, every now and then raising its body and resting on its hind feet." Besides the peculiarities of its dentition (among which are its numerous prickly-pointed molar teeth), the *Myrmecobrius* is remarkable for its somewhat harsh fur, and long bushy tail, together with the entire absence of a pouch in the female, so that the young hang on to the nipples of the mother absolutely unprotected, except by the long hairs which clothe the under surface of the abdomen. The latter peculiarity, however, likewise obtains in certain members of the next genus *Phascologale*, of which numerous species are found throughout Australia. Mr. Gould, in his work on the Mammals of Australia, figures seventeen of them, dividing them into several sections, *Phascogale*, *Antechinus*, and *Podabrus*. They vary in size from the *Phascogale penicillata*, which is large and strong enough to plunder the settlers' henroosts, down to the *Antechinus minutissimus*—the smallest of known Marsupials, which is not much bigger than the Harvest-mouse of Europe. Two genera of purely flesh-eating animals follow the *Phascologalæ*, and close the series of Marsupials. These are *Dasyurus* with five species, spread over different parts of Australia, and *Thylacinus* with only one existing species, now confined to the mountainous districts of Tasmania. The latter animal is well known to the frequenters of the Gardens of the Zoological Society of London, as one of the finest and most interesting of the whole Marsupial series. The general external appearance of the Thylacine is so much like that of a large dog, that the uninitiated can hardly be persuaded that its proper place is in another order of Mammals, and even professed naturalists have fallen into the grave error of arranging it with the Carnivora, with which, I need hardly say, it has no real affinity.

Having completed our survey of the Implacental Mammals of Australia, we must now consider the Placental series, which, as has been already shown, plays a very subordinate part in this extraordinary Fauna. Putting aside the three Marine Orders—the Seals, Whales, and Sirenians, which have entirely different laws of distribution, and confining our attention to the terrestrial Mammals, we find only three of the orders, namely, the Rodents, Bats, and Carnivores, with any representatives in this strange country. And the Carnivores will be perhaps more fairly excluded altogether from the Australian series, since the solitary member of this group is the semi-domesticated Dingo, hardly to be ranked as a wild species. Quadrumana, Insec-

tivora, Edentata, Pachydermata, and the great order of Ruminantia, for which its fine grassy plains would appear, and as we know by experience *are*, well adapted, are alike unknown to Australia in a state of nature. But let us see a little more narrowly of what the Placental series of Australian Mammals does consist.

The Rodents of Australia, although, as we are informed by Mr. Gould, "numerous in species, and almost multitudinous in individuals," are certainly not well developed as regards generic forms, being only represented by three genera of the family Muridæ. These are the cosmopolitan *Mus* and two forms peculiar to the country, *Hydromys* and *Hapalotis*, of which three genera, altogether nearly thirty species, are found in Australia.

Of the Bats of Australia, we can hardly say that enough is yet known to allow of deductions being drawn as to the presence or absence of peculiar forms. Mr. Gould has figured twenty-three species of this order in his great work. Four of these belong to the fruit-eating family Pteropodidæ, so extensively diffused throughout the Indian Archipelago, and are, perhaps, of comparatively recent introduction into the Australian Fauna. The Insectivorous families of the Chiroptera are represented by four genera, but it is a noticeable fact that but one of them (*Nyctophilus*) is a form peculiar to Australia; the other three, *Molossus*, *Rhinolophus*, and *Taphozous*, being genera of wide distribution.

The Carnivora, as I have already stated, are only represented in Australia by the semi-domesticated Dingo (*Canis dingo*).

The subjoined table will serve to show at a glance, the results we have thus arrived at concerning the Australian Mammal-fauna.

Terrestrial Mammals of Australia.

Order.	Family.	No. of Species.
	IMPLACENTALS.	
Monotremata	Ornithorhynchidæ	1
	Echidnidæ	2
Marsupialia	Macropodidæ	49
	Phascolomyidæ	4
	Phalangistidæ	19
	Peramelidæ	8
	Dasyuridæ	24
		107
	PLACENTALS.	
Rodentia	Muridæ	29
Chiroptera	Pteropodidæ	4
	Rhinolophidæ	3
	Noctilionidæ	1
	Vespertilionidæ	15
Carnivora	Canidæ	1
		53

In conclusion, the peculiarities of the Australian Mammal-fauna, which distinguish it in the most marked way from that of every other part of the world may, I think, be put as follows:—

1. The presence of the only known members of the bird-like Order Monotremata.

2. The great prevalence of Marsupials, two-thirds of the whole of the known Mammals of Australia belonging to the single order.

3. The absence of all Placental Mammals, except Rodents, Bats, and a single Carnivore.

EXPLANATION OF THE ILLUSTRATION.

Mr. Wolf's plate represents a moonlight scene on the verge of an Australian forest. In the foreground, facing the observer, to the left is a Wombat (*Phascolomys lasiorhinus*); to the right an Echidna (*E. hystrix*). In the open background are some Kangaroos (*Macropus major*). A Koala, or "Native Bear" (*Phascolarctos cinereus*), is slowly climbing a tree, on the branches of which a group of Phalangers (*Petauri*) and Tarsipes are disporting themselves, whilst a large Flying Phalanger (*Petaurus taguanoides*) is crossing the open space in full flight to the base of an adjoining tree.

THE HISTORY OF THE BRITISH COAL MEASURES;

Being an Account of the Range and Distribution of the Coal Formations beneath the more Recent Strata of the Central and Southern Counties of England.

By EDWARD HULL, B.A., F.G.S., &c.

ON a former occasion* I ventured to give a condensed description of the several coal-fields of Great Britain, along with an estimate of the mineral resources of each; and I then endeavoured to show that several of the principal coal-fields of the central counties of England are not to be regarded as independent, or self-contained, tracts of coal-bearing strata, but are in reality the uncovered portions of a formerly continuous sheet of these rocks, the greater part of which is now overspread by formations of more recent age. To the reader who is not thoroughly versed in the physical geology of our island, the general arrangement of these various formations may be rendered more intelligible by regarding for a moment the coal-fields as islands rising from a sea of the newer strata. Like most similitudes, however, this one does not bear to be carried too far, for while all land-surfaces (islands as well as continents) are connected under the ocean, some of our coal-tracts (as I shall endeavour to show) were originally dissevered from others by intervening barriers of Siluro-Cambrian lands.

The determination of the question regarding the nature and age of the strata which underlie those wide undulating tracts of red marls,

* 'Quarterly Journal of Science,' vol. i. p. 24.

sandstones, and conglomerates which go to form the Triassic and Permian formations of the central counties, as also the Liassic, Oolitic, and Cretaceous groups of the eastern and southern counties, is one of the most interesting problems which it is the province of the geologist to solve. It is, in fact, a compound problem, embracing several questions concerning the physical geography of our island before, during, and after the formation of the coal-measures* themselves. It was once supposed that all the formations from the coal-measures upwards succeeded each other with such regularity and persistency, that whenever one group was found at the surface all the earlier groups were certain to occur beneath. More recent observations, however, have tended to dispel this illusion, and to show that the Carboniferous rocks have been deposited over certain ever-widening depressions more or less bounded by tracts of land which never were submerged during the whole period; and that as regards the Carboniferous groups themselves, and those which succeed them, they are to be regarded *not* as a series of heterogeneous strata deposited without plan, in some places more thickly than in others, without the possibility of determining where the thickness may be greater or less, but as a series of wedge-shaped layers lying one over the other along certain well-determined bearings of the compass. These conclusions lead us to note some remarkable coincidences in the physical geology of Great Britain, upon which we shall touch at the conclusion of this paper.

The subject naturally divides itself into four heads:—

1. Nature of the floor over which the Carboniferous strata were originally spread.
2. The distribution of the Carboniferous strata themselves.
3. The distribution of the formations which overlie the Carboniferous strata.
4. The mutual relationship of these formations, and their teachings.

In treating on these subjects I shall avail myself of the views expressed by several writers on the physical geology of our islands, to whom once for all I beg to express my acknowledgments.†

1. *The Nature of the Floor and Original Margin of the Carboniferous Strata.*

The rocks which precede in point of time the Carboniferous are referable to three great systems—the Cambrian, Silurian, and Devonian; and it would seem that at the close of each of the last-named periods in the north of England and Wales, the rocks were upheaved into islands, or it may be into land which was continuous over the

* The term "coal-measures" is that generally used to denote the upper Carboniferous rocks which contain the principal beds of coal in England; they consist principally of shales, clays, and sandstones of various kinds formed in the sea.

† Amongst others I would specially refer to Professor Phillips ('Geology of Yorkshire'); Professor Sedgwick ("Memoirs on the Formations of the North of England," 'Geological Transactions'); Mr. Jukes ('Memoir on the South Staffordshire Coal-field'); Mr. Godwin-Austen ('Quarterly Journ. Geol. Soc.,' vol. xi.). Some of the points in this paper have been treated of by myself more fully than space will allow of here, in two Memoirs in the 'Journ. Geol. Soc.,' vols. xvi. and xviii.

present bed of the Irish Sea, extending into Ireland and the Atlantic. The unconformable position in which the beds of Old Red Sandstone rest on the Silurian formations in these parts, conclusively proves the date of these great movements. In South Wales, however, the Carboniferous beds succeed the Devonian in a nearly regular sequence, and there does not appear to have been the same amount of disturbance and denudation as in the north. The result is, that in the north of England and Wales the floor of the Carboniferous beds is formed for the most part of Cambro-Silurian rocks; in the south, of Devonian.

If we extend our inquiries into the central and eastern counties of England, we pass into a region where actual observation has, for the most part, to give place to deduction. The points where the Pre-Carboniferous rocks are brought into view are few and far between, but by observing the changes which the coal-measures undergo on approaching these landmarks (as we may be allowed to call them), and endeavouring to find the connection of these points with each other, we have, I think, sufficient data for reasonable conclusions on the subject. Now whenever these Pre-Carboniferous rocks show themselves, whether rising from beneath the coal-measures, the Triassic, or later formations, they are found to belong either to the Cambrian or Silurian systems, never to the Devonian; we may therefore conclude that the floor of the Carboniferous rocks over this area is, for the most part, if not altogether, composed of Cambro-Silurian beds.

Having thus determined the nature of the floor over which the Carboniferous strata were deposited, let us now endeavour to trace the original margin of the coal-formation as indicated by the uprising of the older rocks at various points.

The most conspicuous uprising of these beds in the heart of England is in Charnwood Forest, Leicestershire. The Cambrian rocks are here brought up on the east of the coal-field by a fault, but this only hastens their natural appearance, as forming the original margin of the coal-measures in that direction. There are several other spots farther to the east where bosses of trap, apparently of the age of the Charnwood Forest rocks, reach the surface through the red marls of the Trias, indicating the total absence of the coal-measures. From these points, if we trace the boundaries of the coal-fields of the Midland Counties through Warwickshire, South Staffordshire, Worcestershire, and Shropshire into North Wales, we shall find frequent evidences of the proximity or actual appearance of a ridge or barrier of land which, I believe, formed the margin of the Carboniferous area across the centre of England. Space will not admit of detailed reference to each of the spots where the old rocks reach the surface. They occur near Atherstone, west of Birmingham, and at the Licky Ridge north of Bromsgrove. In these spots the rocks are of Cambro-Silurian age. In Shropshire, however, as at Bridgenorth, the Devonian formation appears, having originally formed in some places the margin of the Carboniferous area. The Silurian rocks, however, predominate, and furnish the margin at Wellington, Shrewsbury, and along the banks of the Severn into North Wales. The spots here indicated do not lie

in a regularly curved line, but as it were in a series of promontories jutting northward from the mainland, which we may call "The Barrier." (*See map.*) The northern margin appears to have been irregular in outline, frequently indented with bays, in which tracts of coal-measures were formed, such as the coal-fields of the Forest of Wyre and of Warwickshire. In some places only the very uppermost beds were formed, the land not having been submerged till towards the close of the period. This barrier of land is shown on the accompanying map, crossing the centre of England in a narrow and indented band.

The southern margin of the barrier can only be very roughly determined. The northern limits of the great coal-tract of South Wales must have extended far beyond its present bounds, and the same may be said in a lesser degree of the coal-fields of the Forest of Dean and Somersetshire. It is therefore probable that the greater part of the slaty region of South Wales was once covered by beds of coal, and that along the valley of the Severn the barrier was extremely narrow at the close of the Carboniferous period. Mr. Godwin-Austen has shown the probability that a band of coal-measures originally stretched across the south of England from Somersetshire into France and Belgium. That this band did not stretch far to the north of the estuary of the Thames there is reason for concluding, from the results of the boring experiments at Harwich. Here cleaved slaty rock of Silurian or Cambrian age was reached beneath the Cretaceous beds, without a trace of the intervening formations. We may well believe that this slaty rock forms but a part of the tract of ancient land which stretches under the Eastern Counties, and of which the rocks of Charnwood Forest formed the margin towards the north-west.

From the above observations it will be seen that the coal-measures of England formed originally two separate areas, one lying to the north, the other to the south, of The Barrier, as indicated in the map. These have subsequently been broken up and formed into separate "coal-fields," which may be thus arranged :—

Coal-fields North of The Barrier.—North Wales, Forest of Wyre, North Staffordshire, South Staffordshire, Warwickshire, Leicestershire, Derbyshire, and Yorkshire, Northumberland, Durham, and Cumberland.

Coal-fields South of The Barrier.—South Wales, Somersetshire, Forest of Dean, and supposed band along the Thames valley.

The coal-fields of the central valley of Scotland were probably connected with those of the north of England, round the eastern coast, but space does not admit of further reference to them on this occasion.

2. *The Distribution of the Carboniferous Strata themselves.*

There are three main causes tending to increase or lessen the thickness of any group of strata at special points of its area during deposition. First, the sediment may be deposited over a deep-sea bed, or a shelving shore; secondly, the sediment deposited may be near or

at a distance from the source of supply; and thirdly, the velocity of the current may be great or small, the transporting power of which is as the sixth power of the velocity. Observations on the accumulated thickness of strata or groups are instructive, as tending to throw light on these questions, but the subject regarded in this light has not received its due share of attention. Classifying the strata which compose the Carboniferous group into Calcareous and Sedimentary,* and confining our attention to the latter, we can compare the relative thickness of these beds with their representatives in various parts of the country, and in so doing arrive at some very interesting results, for we find the thickness changing according to a definite plan or arrangement. On the north side of The Barrier we find a constant diminution in the vertical thickness of the group on proceeding from north to south, while on the south side of The Barrier the decrease takes place from west to east, showing a change of physical conditions, and the marked influence which this dividing ridge has exerted upon the distribution of the sedimentary materials.† Supposing the velocity of the currents which have transported the sand and clays of the coal-measures to have been the same on both sides of The Barrier, we may conclude that the thinning of the beds arises from the two first causes above stated, namely, the approach to a shelving shore and the diminishing supply of sediment as the distance from the sources of supply increases. It would therefore appear that north of The Barrier the source of supply lay to the north; and south of The Barrier the source lay to the westward. These sources must have been lands traversed by rivers, bringing down sand and mud which the currents of the sea took up and distributed over the ocean bed.‡

As illustrations of the thinning away of the beds on either side of The Barrier from north to south in one case, and from west to east in the other, let us take the following from districts lying in nearly direct lines in each case, which have been very carefully measured during the progress of the Geological Survey.

NORTH OF THE BARRIER.

	Lancashire. Feet.	North Staffordshire. Feet.	Leicestershire. Feet.
Upper Coal-measures .	2,000	1,000 }	2,000
Middle " .	3,500	4,000 }	
Lower " .	1,800	1,000	1,000
Millstone Grit .	3,500	500	50
Yoredale Beds .	2,000	2,300	50
	12,800	8,800	3,100

* That is, limestones on the one hand, and sandstones, clays, shales, &c., on the other.

† I take for granted that all my readers admit that the *sedimentary strata* have been deposited from sands, mud, &c., held in suspension by the sea and carried by currents.

‡ The depth of shading on the map will indicate what may be considered the deep and shallow parts of the submerged areas.

SOUTH OF THE BARRIER.

	Glamorganshire. Feet.	Forest of Dean, Gloucestershire. Feet.
Coal-measures	11,650	2,765
Millstone Grit	3 0	455
	11,980	3,210

From the above examples it will be observed that between Lancashire and Leicestershire there is a falling off, in a distance of about seventy miles, of about 10,000 feet of strata, and between Glamorganshire and Gloucestershire, in a distance of about fifty miles, a falling off of about 8,000 feet. Similar results might be obtained by comparisons along parallel lines of country.

The question may now be asked, "What does this prove?" The answer, I think, is plain; it proves the gradual dying out of the coal-formation towards the Eastern Counties, and affords grounds for the belief that even if there had existed no barrier of land in this part of England, the formation would have failed to extend itself under the Cretaceous districts. The Barrier has, however, formed the termination of the northern coal-area towards the south-east, as well as of the southern coal-area towards the north-east, in both instances more abruptly than would have resulted from the mere thinning out of the beds; on these grounds I have left unshaded the part of the map forming the Eastern Counties.*

3. *The Distribution of the Formations overlying the Carboniferous.*

We now approach the third topic of our inquiry, and in doing so shall limit ourselves to the Permian, Triassic,† and Jurassic‡ formations. The lowest member of the Permian formation (the *Rothe-todt-liegende*) is extremely variable, and seems to have been deposited in a depression formed in the Carboniferous beds of which Warwickshire may be considered the centre. Here it reaches a thickness of 2,000 feet, and thins away from this centre in every direction. The upper member, or magnesian limestone, is for the most part confined to the north-east of England. Coal may be considered as within workable reach whenever it occurs under the Permian formation, provided this latter forms the surface of the ground, and the depth will not exceed 1,000 yards.

When we come, however, to consider the distribution of the formations which succeed the Permian, we cannot but be struck with the regularity of the plan upon which they have been formed. We have already seen the manner in which the Carboniferous strata increase and decrease in certain directions. Now it has been found, on comparing a series of carefully-measured sections and tracing the subdivisions of the Triassic group, that they undergo a like decrease in

* I may again refer to the Harwich boring, which in a remarkable degree corroborates the above inferences.

† *Triassic*—comprehending new red sandstone and marl.

‡ *Jurassic*—those of the lias and oolite.

thickness from the north-west towards the south-east of England, so that a series of lines, each representing a certain thickness of beds wherever drawn, would be found to cross the country obliquely from south-west to north-east.* The Trias attains its greatest vertical development in Lancashire, and from this gradually thins away towards Warwickshire; so that while in the former county the thickness may be placed at nearly 5,000 feet, in the latter it is only 600 where it passes below the Lias. Here we lose all sight of it, but judging from analogy, we may conclude that it thins away altogether somewhere about the line of the chalk escarpment; and we know from actual experiments that it does not reach the sea at Harwich.

By a series of similar comparisons we find that the Lias undergoes a similar change in thickness, dying off towards the south-east; and there is reason to believe that the succeeding clayey beds of the oolitic groups prove no exception to the rule. Now as these formations, owing to denudation,† terminate abruptly in the direction of their maximum of thickness, in other words, towards the north-west, we may regard them as a series of great wedges lying over each other in succession, with their thin edges directed towards the south-east coast, but never actually reaching so far.

The view here adopted of the close proximity of the ancient Cambro-Silurian rocks beneath the Cretaceous in the south-east of England receives confirmation from certain characteristics of this latter group itself. Conglomerates, consisting of black hornstone, slate, and quartz, are not uncommon; and in the notable sinking made in search of water at Kentish Town, near London, a conglomerate of syenite, greenstone, porphyry, quartz, and schistose pebbles was reached at a depth of 1,122 feet from the surface. These pebbles being the *detritus* of subaërial rocks in the neighbourhood of the strata which were being formed over the bed of the sea at the commencement of the Cretaceous period, seem to indicate the total absence of the softer strata of the later Palæozoic and earlier Mesozoic periods.

4. *The Mutual Relationship of these Formations, and their Teachings.*

From the above considerations it will be apparent that while the coal-formation attained its greatest development in the north of England, the formations which overlie it also attained their greatest vertical dimensions in nearly the same direction; and since the coal-measures are brought to the surface in Lancashire, Staffordshire, and North Wales, it follows that the elevating forces and the agencies of denudation have acted with greatest effect over these parts, that is to say—*looking at the beneficial results*—where most needed. How impenetrable would have been the covering which once overspread the coal-measures of the north-west of England may be judged by estimating the thickness of the strata which we may infer formerly covered

* Such lines I have traced for the Carboniferous group under the term "isometric lines." See 'Quart. Journ. Geol. Soc.,' vol. xviii. p. 127.

† "Denudation" is a term used to express the sweeping away by the sea, rivers, &c., of portions of the strata.

the Lancashire coal-field to a depth of 7,000 feet, distributed as follows :—

	Feet.
Jurassic Strata	1,600
Triassic „	4,750
Permian „	650
	7,000

This enormous amount of material which buried the precious deposits of mineral fuel has been swept away, and the north-western coal-fields have been brought to light. In the Central Counties little more than half this amount needed removal in order to disclose the coal-fields of those districts; further east the amount was still less, but *there* we approach the margin of the original coal-tract itself. We arrive, therefore, at this conclusion—that Nature put forth her greatest efforts when there was work to be done for a certain beneficial end; in other words, the utilization of the mineral fuel which had been stored up for countless ages beforehand.

Now let us for a moment reverse the picture. We can easily conceive the elevating forces which have upheaved the formations towards the north-west, acting in such a manner as to have upheaved the formations from the south-east. As far as we can see, there is no physical cause why the one should have taken place in preference to the other. In such a case what would have been the result as regards ourselves, our commerce, our position as a nation? It has been shown with a certainty only short of demonstration that there is no coal under the Eastern Counties, and that the coal of the Western has once been placed at inaccessible depths by enormous accumulations of more recent strata. If, therefore, the upheaval and denudation had taken place from the south-east, it is perfectly clear that the coal-fields of the North-west and Central Counties would have remained buried at unapproachable depths; and in the east of England, a region composed of granitoid or slaty rocks would have been brought to light; in a word, we should have had a region in Suffolk such as North Wales, and one resembling Cambridgeshire in Lancashire.

But we cannot shut our eyes to the fact that however large the areas of coal which Providence has placed within our reach, still larger areas are concealed to view, and an extent of coal-ground equalling the whole of that now remaining, whether at the surface or below it, has been entirely swept away. If we compare the extent of the original coal-formation, as shown on the map which accompanies this paper, with that given in the first Number of this Journal showing the actual coal-areas, we shall be struck with this fact. Nature in this case, while operating for the future benefit of the patient, has not neglected to make use of the knife; but as it is better for a patient to lose a limb in order to save his life, so we have no right to complain if our present extent of coal-surface has been secured at the sacrifice of even a large part of the original area.

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M & N Hanhart

ON THE CAUSES OF BRITAIN'S GREATNESS.

A Review of the Relations of her Geology and Geography to her History.

By W. PENGELLY, F.R.S., F.G.S.

A FORMAL attempt to prove that Britain is pre-eminent amongst the nations, whether ancient or modern, for manufactures and commerce, would be a work of supererogation. The proposition is firmly believed by ourselves, and admitted by our neighbours.

It may not be uninteresting, however, to throw into a readable form a few of the huge numbers employed by the statistician to show the greatness of our commercial transactions. A glance at our import and export tables reveals not only the magnitude of our undertakings, but also our national character and position. Our imports are mainly food and raw materials ; our exports chiefly manufactured goods. We see a teeming, industrious artisan population occupying a country which does not grow food sufficient for them.

In 1860 we exported cotton goods to the value of over fifty-two millions sterling ; the cotton cloth alone amounted to more than two thousand seven hundred and seventy-five millions of yards, that is to say, to more than one million and a half of miles, or more than sufficient to reach from the earth to the moon six times and a half. Had the price of this cloth been increased by one farthing per yard only, the sum thereby produced would be upwards of two millions eight hundred and ninety thousand pounds sterling, or one hundred pounds per annum for nearly thirty thousand families. Invested at three per cent., it would produce an annual dividend of nearly eighty-seven thousand pounds, or sufficient to give constant employment to two thousand two hundred and thirty labourers at half-a-crown per day each. The fact that, in consequence of the unhappy American war, our exports of cotton cloth sank in 1862 by upwards of one thousand million yards, shows how dependent we are on foreign countries ; and our continued national prosperity, notwithstanding the cotton famine, shows also the greatness of our other manufacturing industries.

Omitting upwards of three hundred and sixty thousand tons of flour and meal, we imported in 1862 sixteen millions of quarters of corn, or sufficient to build a wall thirteen inches thick, twenty feet high, and one thousand four hundred and sixty miles long, that is, the perimeter of the triangle of which the Land's End, the North Foreland, and Dunnet Head are the angular points ; in other words, to build a wall entirely around Great Britain. In the same year we received from foreign lands upwards of four hundred and fifteen thousand live animals, or one thousand one hundred and thirty-eight every day throughout the year ; besides more than two hundred thousand tons of animal food, as bacon, &c.

The machinery used in our carrying trade is, of course, on a scale commensurate with the trade itself. In 1862 we employed in our foreign and coasting trade four hundred and twenty-four thousand ships, having an aggregate tonnage of sixty-one millions six hundred

thousand tons. On the average throughout the year, nearly fifty vessels left a British port every hour, each carrying one hundred and forty-five tons.

The total length of railway open for traffic in the United Kingdom at the end of the year just mentioned, was upwards of eleven thousand five hundred miles, at a cost of very nearly three hundred and eighty-five and a quarter millions sterling.

In the same year the post-offices of the United Kingdom delivered six hundred and five millions four hundred and seventy-one thousand letters, seventy-three million newspapers, and fourteen million book parcels. Had the letters been placed in ordinary envelopes—about four inches and three-quarters in length—these placed end to end, would form a straight line nearly forty-five thousand four hundred miles in length. Assuming each person on the post-office staff to be an adult male and the head of a family of five persons, the entire establishment represents a population larger than that of Herefordshire, larger than the joint population of Huntingdon and Westmoreland, and nearly six times that of Rutland.

The wealth which our manufacturing and commercial activity brings us, is seen in the luxuries in which we indulge.

If the tobacco consumed in the United Kingdom in 1862 had been made into cigars and packed in one-pound boxes of the ordinary dimensions, they would have formed a wall, one box thick, twenty-four boxes or ten feet three inches high, and over two hundred and fifteen miles long; that is, more than the length of the railroad from Paddington to Newton Bushel in Devonshire. It is frequently said, "that few men smoke a dry pipe," and the following figures will show that the saying appears to rest on a basis of fact. We paid duty for home consumption in 1862, on upwards of three hundred and seventy-three millions of gallons of wines, British and foreign spirits, and malt liquors; in other words, our alcoholic beverages for one year—exclusive of cider, perry, home-brewed beer, British wines, and smuggled goods—would fill a canal three feet deep, six feet wide, and six hundred and forty miles long; that is, forty miles in excess of the distance from the Land's End to John O'Groats!

The commercial activity, and the consequent wealth of Great Britain are portions of history, and must be regarded as such, even if they were isolated facts; but it cannot be forgotten, that the occupations of a people affect their mental development, and, consequently, their institutions; the artisan is, without doubt, more intelligent than the farm labourer; whatever, therefore, stimulates the manufactures of a nation tends to render the working classes more intellectual and more important socially and politically, and thus to foster the growth of popular institutions.

Now, though it is certain that some of our waste lands may be reclaimed, and possible, perhaps, that additions may be made in other ways to our cultivated acreage, it is highly improbable that the growth of area can keep pace with the growth of population; there is a limit perhaps to each, but that of the former will certainly be reached long before we approximate that of the latter. The population of England

and Wales in 1801 was something over nine millions, in 1861 it was nearly twenty and a quarter millions, the increase being more than one hundred and twenty per cent.; at the former period there were one hundred and fifty-eight persons to the square mile, at the latter there were three hundred and fifty.

In 1861 the population appears to have been thus composed:—In every thousand persons, there were twenty-four belonging to the professional class, five hundred and seventy-four to the domestic, thirty-one to the commercial, one hundred and one to the agricultural, two hundred and forty-two to the industrial ("comprising all our manufacturing community as well as those who follow the production of the material to work it up into almost infinite forms of utility and beauty"), and twenty-seven to the indefinite and non-productive; * so that at present the manufacturing alone, bears to the agricultural population the ratio of nearly five to two; and this ratio, in all probability, will increase, because the number of agriculturists will be related to the number of cultivatable acres (already nearly a maximum), not to the general population, which is rapidly increasing; and also because the mechanician, by new inventions and applications, is constantly displacing the farm labourer. The occupation of the masses as a whole, therefore, is steadily changing and in a definite direction, and this, as we have seen, cannot but be followed by a change in the character of the population; moreover it is, at least, relatively diminishing the class from which our armies have been very largely if not mainly recruited.

The accumulation of wealth, too, calls into being a new, a moneyed, —aristocracy, which, to some extent, is a counterpoise to the aristocracy of territory and of rank; and an auxiliary in the de-feudalization (if such a coinage be allowable) of our institutions.

The importance of foreign corn-fields and foreign markets to us, necessarily affects our international treaties, and, through them, the nations with which we come into contact; our true policy is peace and unrestricted trade.

But why is Britain thus great? Whence this pre-eminence? Are there any facts connected with her or her people which will account for the place she occupies? Anything which would have enabled a gifted man to predict her position amongst the nations? In reply, it may be asked, Is not her history the simple result of her structure and situation? Was it not pre-written in her geology and geography?

Let anyone take a common terrestrial globe, and so adjust it that the greatest possible amount of land shall be above, and the least below, the wooden horizon; that is to say, divide the world into two hemispheres, one terrestrial, the other oceanic; one the home of the nations, the other their common highway; and it will be found that the town of Falmouth in Cornwall—and hence we may say Britain—occupies the *centre* of the first; she has the best possible position for the market-place of the world, since her dealers dwell around her on every side. Geologists tell us that their science discloses the fact

* 'Companion to British Almanac, 1862.'

that the distribution of land and water has frequently and greatly varied. At present, rather more than three-fourths of the earth's surface are occupied with water, and something less than one-fourth with dry land; but were it proved that this has been a constant ratio, it by no means follows, nor is it probable, that about three-fourths of the land have always been in the northern hemisphere, nor that twenty-six square miles of dry land out of every twenty-seven have at all times, as now, had water at their antipodes. A slight change in the grouping, and the centre, instead of being in Britain, might be shifted far into some continental mass; say, for example, to Timbuctoo. The bare supposition shows that we enjoy the advantage of *insularity* also.

Now this insular position secures to us numerous advantages, and amongst them that of *accessibility;* it would have availed us little to have occupied an inaccessible centre. But whilst it facilitates communication between our customers and ourselves, it renders us *comparatively free from invasion;* it is less easy to land a hostile force than to march it from one continental country to another. It brings with it also a *large amount of coast;* the civilization of the great divisions of the earth is pretty clearly indicated in the relation of their coast-lines to their respective areas; thus Europe has one mile of coast for every one hundred and fifty-six square miles of surface; North America, one for every two hundred and twenty-eight square miles; South America, one for every three hundred and seventy-six; Asia, one for four hundred and fifty-nine; and Africa, one for six hundred and twenty-three;* or, to throw the same facts into another form, for every ten thousand miles of surface, Europe has sixty-four miles of coast; North America, forty-four; South America, twenty-seven; Asia, twenty-two; and Africa, sixteen; or, again, to give them still another aspect, if we put the relative coast-line of Europe at one hundred, that of North America is sixty-nine; South America, forty-one; Asia, thirty-four; and Africa, twenty-five. It is worthy of remark, too, that a portion of the coast-lines of Europe, Asia, and North America is almost useless as a sea-bord, from its Arctic position. Europe, however, is deprived of comparatively little in this respect; the losses on this account being, for the three divisions respectively, as the numbers nine, fifteen, and twenty.

Now amongst the countries of favoured Europe, the British Islands—and especially Ireland—are, on the whole, the most richly supplied in this respect. Great Britain has one mile of coast for every fifty-seven square miles of area, being about three times greater than that of France and of Europe generally.

The coast advantages possessed by an insular over a continental area are, of course, greatest in small islands. Suppose, for example, two square islands to be—one a mile in length and in breadth, the other two miles long and two broad, their areas are one and four square miles, their coasts four and eight miles respectively; the first has four, the second only two, miles of coast for every square mile of surface. In short the relative coast decreases in the same ratio as the side of

* Guyot's 'Earth and Man,' 1850, p. 39, &c.

the square increases. A small island, however, is incapable of a large population, the nation inhabiting it can never be sufficiently numerous to be very powerful. Now, Britain is *large enough* to sustain a nation capable of commanding respect, yet *small enough* to secure a larger relative coast-line than any other country in Europe.

An island has also the great advantage of *comparative equability of climate.* The sea is less liable than the land to fluctuations of temperature; on several accounts it is cooler than the latter in summer, and warmer in the winter; hence the breezes which blow from it throughout the year are more equable than those coming from the land. Now, excepting those of a very local character, no wind passing over an island of moderate dimensions can fail to be charged with marine influences. Severe as a northerly or north-easterly wind may sometimes be in a British spring, its severity would be unquestionably greater, and we should be less able to bear it, but for the sea with which our island is engirt.

Again, our position is *near the middle of one of the temperate zones.* Had it been within or very near the torrid zone on the one hand, or the frigid on the other, any advantages connected with our situation in other respects would have been greatly impaired. If one may so speak, our energies would have evaporated in the first case, or frozen in the second. "A hot climate," says the late Professor Waitz, "renders physical, and still more mental, labour difficult, induces man to consider every kind of effort as a greater evil, and indolence a greater enjoyment than is the case in temperate or cold regions."* The temperature, however, in our latitudes is not only compatible with labour throughout the year, but may be said to compel it; exercise, another name for work, being essential to the maintenance of health.

Omitting the ellipticity of the earth's orbit and the phenomenon of twilight, the year is everywhere equally divided between light and darkness; but though this law obtains throughout the world, its incidence is variable and depends on the latitude of the place; the greater the latitude the greater the inequality of longest and shortest days, but everywhere the excess of the first, over twelve hours, is always balanced by the defect of the second. Now, taking Greenwich as representing the British Islands, *our longest day is about sixteen hours and a half, and the shortest seven and a half,* that is, from sunrise to sunset; hence when most curtailed the day falls but little below the time in which an industrious man can expend his energies. A few degrees farther North would bring much shorter winter days as well as a severe climate, and a corresponding removal Southwards would introduce a climate unsuited to an energetic race.

The length of day and night, moreover, is of importance in other respects. The acquisition of heat depends very largely on the former, and the loss of it, through radiation, on the latter. In higher latitudes less heat is received, and more lost, during the winter than with us, and the reverse obtains in the summer; the total effect being to augment the difference between the summer and winter temperatures,

* 'Anthropology,' p. 330.

in fact, to produce an extreme rather than an equable climate, a thermal condition more trying to the health than perhaps any other.

Nor should it be forgotten that, on account of the elliptical form of the earth's orbit, the proximity of the perihelion to the winter solstice, the greater amount of land on the Northern than on the Southern side of the equator, and sundry other circumstances into which it is unnecessary to enter here, the temperature of the Northern hemisphere is less extreme in its fluctuations, and on the average is higher than that of the Southern.

There is an advantage, too, in our being on the *eastern* side of the Atlantic. A line drawn round the earth, through all places having the same mean annual temperature, is termed an *isotherm*. Now, lines of this character, instead of coinciding with parallels of latitude, undergo remarkable deflections; for example, the isotherm of 50° Fahr. passes from the Pacific to the continent of Asia in about latitude 42½ N.; it gradually creeps up to 47½ N. between the Aral and Caspian Seas, whence it ascends more rapidly, and enters the German Ocean in about 53° N.; it reaches its highest point in the British Isles, where it touches the parallel of 54° N.; after this it bends southward, until, on entering the American continent, it almost reaches the low latitude of 40° N. In its course across America, its deflection, on the whole, is northerly; and on the eastern side of the Pacific it culminates a second time in 54° N.; after which it bends southwards, and reaches 41½° N., in the Japan Archipelago. In general terms, then, the greatest northern deflections occur on the eastern, and the greatest southern deflections on the western, sides of the two oceans, and this is true of all the isothermal lines north of the tropic of Cancer; so that the eastern sides of the Atlantic and Pacific Oceans are warmer, and the western colder, than is due to latitude merely. In the example traced above, the mean annual temperature of Britain is the same as that of a place fourteen degrees farther south on the opposite side of the Atlantic.

But whence this difference?

Enormous bodies of water move through the ocean in constant and definite directions: some of them from tropical regions towards the poles, others from cold latitudes towards the equator. The rotation of the earth on its axis causes every place to move eastward more rapidly than those more distant from the equator; hence all poleward currents are continually reaching districts moving eastward less rapidly than themselves, and thus outstrip them, or move by them eastward. The reverse of all this obtains in the case of currents from high to low latitudes; relatively, to the parts of the earth they successively reach they move westward; more correctly, less rapidly eastward. In fine, warm currents moving towards the poles impinge on the eastern shores of the oceans to which they belong, and cold currents proceeding towards the equator fall on the western shores. Amongst the great currents of the Atlantic the most celebrated is the Gulf Stream, which, from Cape Florida, pursues a north-easterly course, takes the British Isles in its journey, and, according to Scoresby, even reaches Spitzbergen. Britain is bene-

fited by it both directly and indirectly; directly, by the warmth which it brings us, which, according to Mr. Hopkins, raises the temperature of Snowdon (taken as representing the mean of England) by fifteen degrees of Fahrenheit during the month of January, and our mean annual temperature by half as much; indirectly, by strangling at the beach the glaciers formed in the valleys of Spitzbergen, and which were about to start, as icebergs, to chill the waters washing our northern coasts. Here, then, is a cause for the great northward deflection of the isotherms traversing the north-eastern portion of the Atlantic, and to it may be added the fact that Europe, of the three great northern divisions of the earth, extends least into the frigid polar regions. The lower temperature of the Atlantic sea-bord of North America is due to more than the negative fact that it is not visited by any body of heated water; it is mainly attributable to a current moving southwards from Baffin's Bay, which not only consists of water of low temperature due to its arctic origin, but transports vast fleets of icebergs. Sir John Ross saw several of them in Baffin's Bay, aground in water 1,500 feet deep; that is, fully five times deeper than the English Channel, even between Brest and the Land's End. It is stated by Sir Charles Lyell that the thawing of icebergs, as they drift southward, has been known to cool the water sensibly for fifty miles around, and sometimes as much as eighteen degrees in their immediate neighbourhood. Occasionally a large number are stranded on the west coast of Iceland, where they cause a failure of the crops by the fogs they incessantly generate, and drive the fish from the coasts by the reduction of the temperature of the water.

The British islands are, on the whole, well supplied with harbours and roadsteads. Should the era of large merchantmen, predicted by the 'Great Eastern,' ever be realized, the safe and capacious Milford Haven will be found to occupy a prominent place in the history of our commercial marine.

None of our numerous rivers, of dimensions available for inland navigation, are obstructed by rapids or waterfalls; it is scarcely possible, however, to study the gorges through which some of them pass without being convinced that, in fierce and long-continued conflict with the rocks which bound them, they have won the channels they occupy. We are taken back to a remotely distant time when some of our streams fell helplessly over opposing ledges; we see the fall slowly dwindle into a rapid, and this in its turn give place to a river of tranquil flow.

How much, also, do we owe to our vast and varied *mineral wealth!* The metals of Britain influenced history before the dawn of modern civilization. The adventurous and enterprising spirit which led the early Phœnician to Cornwall in quest of the tin it contained, was no doubt thereby fostered and developed, as well as transfused into the ancient Cornubii. Our mineral produce in 1862 was worth more than thirty-four and a half millions sterling; of this vast sum the value of the coals was considerably over twenty millions, and of the iron nearly ten millions. It has been said that "iron is the backbone of nineteenth-century civilization;" it may be added that coal is the

pabulum on which the giant feeds, and steam the fluid which circulates through his veins. It is believed that in 1863 our coal produce did not fall short of ninety millions of tons; that is, the freight of one hundred and eighty thousand ships, each carrying five hundred tons, or nearly five hundred such ships daily, or upwards of twenty every hour throughout the day and night. The importance of this enormous mass of fuel will, perhaps, be best estimated from the fact that it contained a mechanical power equal to upwards of thirteen years' labour, under the most favourable conditions, of thirty millions of able-bodied men—a number exceeding that of the entire population of the British Islands when the census was last taken.

These are among the salient facts connected with the situation and structure of our country, on which the position which she occupies amongst the nations largely depends. Britain is an island of desirable dimensions, rich in the amount and variety of her mineral wealth, and occupying the centre of what may be called the terrestrial hemisphere of the earth. She is well supplied with roadsteads, harbours, and navigable rivers,—is placed within the temperate zone, in the northern hemisphere, and on the eastern side of the Atlantic Ocean. It should be remarked that each of the above facts is independent of all the others. Centrality, for example, by no means necessarily secures a maritime situation, or insularity, or desirable dimensions, or mineral wealth, or harbours, or rivers, or a particular hemisphere, zone, or ocean, or the direction of genial ocean currents. Each is the result of geological operations of incalculable antiquity. The sea is constantly encroaching on the land in some places, and retreating from it in others; and though such changes are in a lifetime appreciable by the initiated observer only, time alone is required to give them a value greater than any that can be assigned. The relative level of land and sea is by no means characterized by stability; for example, Sweden has long been undergoing a slow and gradual upheaval, and Western Greenland has been slowly sinking. A comparatively small elevation of Western Europe would deprive Britain of its insularity. Within its own borders many once-famous harbours have been completely silted up. The elevation of an island or the formation of a coral-reef between Florida and Cuba would rob us of the Gulf Stream.

Geologists tell us that in times geologically very recent, though humanly somewhat remote, our country underwent changes almost surpassing popular belief. They say that within our area the era immediately prior to the advent of man was so intensely cold, as to be appropriately termed "Glacial;" that this divided itself into three periods, of which the first and third were "continental," that is, the whole of the British area stood, at least, from five hundred to six hundred feet higher than now, so that the German Ocean and British Channels were left dry. The higher mountains of Wales and of Scotland were then occupied with glaciers. The second or intermediate period was one of submergence, by which, at least, the land north of the Thames and Bristol Channel, as well as that of Ireland, was carried down certainly fourteen hundred, and probably two thousand three hundred, feet below

the present level, and reduced to an archipelago of small islands This was a period of floating ice.

The position of a country, however, in the family of nations, is a product of which not only physical conditions, but human skill and industry are important factors; hence the question of race enters largely into the speculation; the subject has an ethnological aspect.

The different races into which the human family resolves itself are either the offspring of so many distinct original types, or the outcome of varied external conditions operating, through long periods of time, on the plastic descendants of one primal pair. On the first hypothesis, each original type must have come into being harmoniously related to the pre-existing physical characters of the district in which it was placed; and to this and similar districts its continued existence was necessarily limited. On the second, the race-characters are simply a reflex of the geology and geography of the area in which they were moulded as well as pre-written.

There can be no doubt that Britain and its Anglo-Saxon inhabitants are well adapted to each other. The energy and enterprise, characteristic of the latter, are not only necessary to the development of the resources of the former, but are fostered and fixed by the occupations pre-determined and necessitated by the physical conditions of the country. A district rich in minerals is valuable to an enterprising race only. A body of men can scarcely descend daily into the bowels of the earth, braving the dangers inseparable from such an employment, without being confirmed in any love of adventure which they may possess, and influencing the population of which they form a part. The coal miners of England number upwards of two hundred and forty thousand, and the metalliferous miners of Cornwall amount to very nearly thirty-one thousand, or upwards of one-twelfth of the entire population of the county. We can scarcely send this body of men—a total of more than a quarter of a million—underground daily, there to become familiar with danger in various forms, without being prepared to find in them and their offspring a character very unlike that of an agricultural population. Moreover, where, as in Cornwall, each miner is, in some shape, a partner in the undertaking; where he contracts to cut, at per fathom, rocks—sometimes granite, sometimes slate, sometimes elvan—varying much in hardness and in the possession of divisional planes; or where he is paid by a percentage on the proceeds; his prosperity depends on his observation, judgment, skill, and application. He may take as his motto—"Thought and Perseverance, or Starvation." An education of this kind not only makes him a skilful miner, but prompts him to carry his labour to the best market, even though he may find it at the antipodes. It is not surprising, therefore, that in whatever part of the world metals are found, there also are found Cornishmen engaged in extracting them.

Again, all other things being equal, a population will have maritime tendencies in proportion to the relative coast-line of their country; hence an unusually large percentage of the British nation are fishermen and sailors—that is to say, men familiarized with hardship and danger, and compelled to think; and this is probably true

of coasters and fishermen in a higher degree than of sailors who make long voyages, since the dangers and difficulties are much greater in the two first cases than in the last, both in proportion to the mileage and to the men who really have to encounter them. With a good ship and plenty of sea-room a sailor has little to fear from any storm; moreover, the officers only (and in large ships they are few in proportion to the crews) address themselves to such difficulties as require thought. In small coasting, and especially fishing craft, where the crews frequently consist of two, and rarely of more than three or four, hands, every man is called upon to be a pilot; he must be acquainted with every rock and shoal, with the tidal phenomena of the district, with the indications of change of weather, and under the guidance of this knowledge he makes his voyage or selects his nightly fishing-ground; he becomes skilful in the management of craft, and adventurous in habit. And here, again, we may turn to Cornwall for illustration. Projecting farther than any other part of the island into the warm seas of the south and west, and possessed of a relative coast-line nearly twenty times that of even Great Britain as a whole—indeed, nearly twice that of any other English county—it is not surprising that her coasts swarm with seafaring men. The well-known dark-brown lug sail of the Mount's Bay fishing-boat is seen, not only in every part of the British Archipelago, but a few years ago a crew of six men, in one of these boats, undertook and performed the voyage to Australia, and that only for the purpose of fishing there. A gentleman, who knew the parties well, told the author of this paper that a fearful storm which they encountered in the Indian Ocean was duly chronicled in their well-kept log, and accompanied with the characteristic remark—"It would take a good ship to stand this storm, but our boat behaves admirably."

"A nation of shopkeepers" should be distinguished for integrity, and, though we may be sometimes compelled to regard commercial morality as an adulterated article, it remains to be a truth, well recognized by the British merchant, that "honesty is the best policy."

The genuine Englishman is also characterized by a love of independence and a resolution not to be content with the bare necessaries of life. "Potatoes and salt may keep body and soul together," but he expects the accompaniment of beef, which he would rather earn than permanently receive as a gift; he cannot afford to be lazy or improvident, hence he largely avails himself of Friendly, Provident, and Co-operative Societies, and Penny and other Savings-Banks. No doubt some of these schemes are ill-advised and prove to be failures, but this only serves to throw his providence into greater prominence, since successive disappointments of this kind have entirely failed to eradicate this trait of character. On November 20, 1862, the number of individual depositors, charitable institutions, and friendly societies in Savings-Banks was upwards of a million and a half, and their deposits amounted to more than forty and a half millions sterling. In the year just mentioned somewhat under six hundred thousand persons deposited very nearly one million nine hundred and fifty thousand pounds in the Post-Office Savings-Banks of the United

Kingdom. We have here the nucleus of many a future capital, and a material guarantee for good order.

Pecuniary prosperity is so firmly believed in by Englishmen, as to cause them to take what are called "Practical Views." Discoveries and inventions are prized in proportion as they can be shown to have a money value. Every new thought presented to the British mind is met with the question, "What good is it?" It is thrown on the counter of the money-changers, and received or rejected according as it has or has not a utilitarian ring. Though this trait must be regarded as a taint, it is inseparably connected with commercial activity and success.

The political institutions of a country are probably amongst the most faithful transcripts of the mind of the nation occupying it; and ours, whether logical or not, undoubtedly work admirably. No one abstains from sowing, because of any uncertainty as to his reaping and enjoying the harvest. The exiled chiefs of once rival parties may together enjoy our political hospitality without disturbing us, or even exciting attention. In more than a solitary instance, however, political refugees have brought us their arts and laid the foundation of important branches of trade.

Numerous questions and inferences, which suggest themselves in connection with the subject of this paper, must be omitted. The theme is a fertile one, and illustrations of its central idea abound in every country. *Our rocks are at once historical and prophetical.* They contain the wondrous history of their formation, of changes in the distribution of land and water, of the birth of mountains and rivers, of fluctuations in climate, and of the extinction of a vast and varied multitude of animals and vegetables which have successively occupied the earth. They also contain, in prophecy, the histories of unborn nations. Occupations, mental developments, institutions, lines of policy, are all pre-written within the rocks beneath us. The prediction may long wait a fulfilment, but it is none the less certain. Incalculable ages ago gold was deposited in Australian quartz. Incalculable ages since, then, a prediction was inscribed on the rocks of Australia, that sooner or later she would be favoured with an immense influx of civilized human beings from every part of the world, bringing with them their accomplishments, their industries, and their enterprise.

ON THE ORAL INSTRUCTION OF THE SO-CALLED DEAF AND DUMB.

Being some Account of the System of Tuition by "Lip-reading" and Articulation.

By GERARD VAN ASCH, Manchester * (late Teacher at the School for the Deaf and Dumb, Rotterdam).

THE articulation of the deaf and dumb is of such rare occurrence in this country that, to a casual observer, it might appear reasonable to think that all attempts to produce it must have been idle efforts without any result.

By many, dumbness is thought to arise from malformation of the vocal organs, or from some similar cause directly connected with these. But to those who have given this matter any consideration at all, it will need no second reflection to pronounce this a false notion. They will account for the affliction by the derangement or absence of certain parts of the internal ear, such as the auditory nerves, the drum, the chain of bones in the ear, &c., which disturbance prevents sounds from being perceived, and therefore from being imitated. The organs of speech in persons so afflicted present nothing peculiar; indeed, the deaf of tender age invariably exhibit a tendency to use them like hearing persons, and they imitate with pleasure directly they are shown the example and method of imitation. As their condition, however, admits only of their receiving a crude notion of vibration, the task of instruction is very difficult; for what comparison is there between the subtle nerves of hearing and those of touch, which form their only substitute? But difficulty does not imply impossibility; and a close study of the formation and variations of sounds, as they emanate from man's vocal organs, supplies a key of such value to the teacher of mutes, that it may serve him as an instrument to guide their endeavours to articulate, and to acquaint them practically with the principles on which the structure of our language is founded. The research will reveal many of those obstacles which it is needful for the deaf to overcome; it will disclose the elements that must serve as stepping-stones that will lead to the height, and will determine the course best calculated for them to follow.

Led by such knowledge, it is possible not merely to sift out easy consonants and vowels, and suitable combinations of these, but also words, and even sentences, which should be set apart for practice. In fact, by it may be determined whether one language is formed superior to another for the imitation of the deaf; and no doubt the English tongue must have presented greater difficulties to Wallis than the Dutch did to Amman, when these two simultaneously undertook the task of teaching articulation to some deaf children in England and

* This article is intentionally printed, with the most trifling alterations, in the words of the author, who has been in England five years, and knew nothing of the language on his arrival. This course appeared to the Editors to be the fairest towards Author and Readers.

Holland. An intimate acquaintance with the structure of language has indeed caused some persons engaged in this branch of education in Germany and Holland to entertain doubts as to the adaptability of the English and French languages for such purposes.

It is impossible here to enter into a discussion of the subject, or to attempt to refer fully to the different sounds and methods of teaching them to the deaf, and we therefore prefer to give publicity to effects attained rather than theoretical opinions. After an experience of five years with a class of deaf children, we cannot help agreeing that the utterance of the English language presents several difficulties not met with in Dutch and German; but in how far we have succeeded in combating with those difficulties will be to some extent seen from a perusal of the following cases:—

*First Case, F. R.**—This young lady affords an example of the class usually denominated "stone-deaf," and having probably been born so, it is fair to argue that her case does not differ materially from any of the most discouraging. She is about eleven years of age, and has been taught five years, of which the two first were spent in habituating her to a proper mode of observation, and in creating a love for inquiry; that is to say, in devising different means to excite her curiosity about things adapted to her age and circumstances, and particularly in effecting a series of exercises which should lay the foundation of utterance, and would promote the expansion of the chest. After that time study became more systematical. As we lay particular weight upon the physical attainments of the young deaf, as well as on the improvement of their minds, let us consider first the progress of this pupil *physically*.

Sounds of all classes used in the English language could be made at the end of the first year. The vowels, which it is rather difficult to extract from the totally deaf, were open and comparatively clear; we say comparatively, because it must not be supposed that the clearness of sound under such circumstances can at all equal the rounded tone of those blessed with an acute sense of hearing. The combinations of vowels and consonants could also be pronounced, and the physical power, therefore, of connecting spoken names with the idea of objects and actions was beginning to be developed. Speech, such as it was, was not however without defects.

The manipulation of the tutor, for correcting and facilitating speech is necessary for a considerable period of time; for when first a young mute begins to utter sounds of his own accord, he is frequently in the habit of interjecting letters or sounds which have no connection whatever with the words he wishes to pronounce; or his vowels and complex vowels, such as *i* (pronounced $\bar{a}\,\bar{e}$, as in *far* and *be*), are deteriorated by the practice of forcing the sound through the channel of the nose. The teacher, then, must be able to detect all these discrepancies, and would greatly neglect his work if he were to abstain from instantly rectifying these deviations from the true mode of articulation.

Returning to the pupil whose case we are considering, another advantage gained by her during the first year was the quickness of the

* The initials are, in all cases, slightly altered from the actual ones.

eye to distinguish variations in the position of the lips when moved slowly, and the ability to imitate these movements.

Exchange of thought is known to be of the greatest importance to the health and strength of mature minds, but what must it be to the growth of an immured infant mind? It is impossible to estimate the vast importance to be attached to the ability, in the deaf, of reading the lips, for to them the movements of the latter replace all the operations of sound, and it is their means of receiving the information needful for keeping up a healthy action of the brain. The early training of the vision, as well as of the vocal organs was, in this instance, not without its recompense. The pupil made use of her new faculties during the three succeeding years in a remarkable degree. The eye became gradually more efficacious to catch the observations of her parents, brothers, and friends, whilst the employment by her of organs of speech rewarded doubly the labour which had been bestowed upon her.

It is at present most gratifying to witness the pleasure which the child derives from her ability to read from her parents' lips whatever information they may have to communicate to her. Any words or set of words are conveyed by the eye to the mind almost as fast as they can be pronounced distinctly and separately; and for reasons already given, it is of no consequence whether or not sound is connected with the uttered word or sentence; the pupil catches the meaning of every position of the lips or facial muscles provided the organs of speech perform the same motions without as with the creation of sound. Speech is now inseparable from her social state and feelings; in fact, she has often been heard to talk in her dreams.

Let us now consider the *mental* progress of this pupil.

As we have already remarked, the mental faculties of the infant deaf must not be overburdened nor exercised too long. Half-an-hour's practice at a time will suffice. This pupil, accompanied by one to be called F. O., also a young girl, spent much time with us in the open air during the first two years, and we made a practice of showing them anything which attracted their attention, teaching them the names, and, as far as possible, the uses of objects. At the end of that time the pupil was consequently acquainted with a variety of trees, herbs, animals, road implements, grain, &c.; knew the difference between river, brook, and ditch; sand and clay, &c.; in fact, knew from her own observation a vast number of natural and artificial objects to be seen in our walks, and had derived much benefit from watching the farmer and mechanic. Being taught the words on the spot, the idea connected with the written or articulated name was clear, and the scene of action could be brought vividly before her.

She was able to understand such questions as—"What did the farmer cut?" "Where have you been?" "Who was out with you?" "Is the poplar dead?" Original questions put by herself would be shaped thus:—"What farmer cut?" "Who walk with you?" &c.; it being understood that the latter were given *vivâ voce*, and the former slowly read from the teacher's lips, and slowly repeated in plain tones by herself.

Similar questions, or simple propositions dictated to her, she could write down, and when they were written for her she could read them with intelligence. A slight acquaintance was also made with numbers; and at the end of the third year she possessed a good idea of the topography of Manchester and its suburbs, a larger understanding of things generally, and a knowledge of addition and subtraction, with numbers up to 100. Truly this was not very far advanced, but we preferred quality to quantity. A few other additions were made to the list of subjects in the fourth year; and now the girl is eleven it is probable that she knows as much as a child of average intelligence of the same age concerning grammar, the geography of the British Isles, the four elementary rules of arithmetic, and the early part of English history.

The following dialogue, taken down by the author *verbatim*, will show the mental calibre and speaking powers of this child. She had had an evening birthday party, and was conversing about it in the presence of her deaf companion, F. O.:—

F. R. "I was astonished to see Mrs. A. Mamma did not tell me." (Meaning, that the lady in question would be at her party.) "I asked her whether she would come to see me. She said, No." (Pause.) "I thought that she made fun with me."

Seeing me writing down the conversation, she said, "What for?"

F. O. (Her companion, also addressing herself to me) "What for? I ask you. Why do you write the same?"

F. R. (Answering her). "Fun! (A pause.) "Papa asked me where was his ring."

Teacher. "No; you must say, 'Papa asked me where his ring was.'"

F. R. "When uncle B. lied" (meaning 'lay on the floor') "Mr. A. rose him up."

Teacher. "No; lifted him up."

F. O. "Fanny's cousin pressed my foot when I danced."

F. R. "Rather rough." (Meaning that her cousin had been careless.)

Teacher (Correcting F. O.). "Trod on my foot."

F. R. "I told him, 'You must be quiet.' I cut the cake for girls."

Teacher. "That is a mistake—'I cut the cake for my friends.'"

F. R. "My papa sat near the cupboard. We could not go to the other side." (Meaning of the room.)

Teacher. "Why was your papa in the way?"

F. R. "Because the table is so long."

Teacher. "Did you ask your papa to make room?"

F. S. "Afterwards" (meaning after tea was over) "Fanny and I went up stairs to see Matilda" (her baby sister), "and she was afraid of Fanny."

Second Case, F. O.

To form an adequate idea of the exact condition of the lost sense of this young lady, it must be born in mind that not all persons who are designated stone-deaf are absolutely so in the strictest sense. A large

number of them, especially many of those whose affliction is accidental (the result of illness in infancy), have a remnant of hearing left, and though that may be exceedingly slight, it cannot escape the notice of the teacher after a few weeks' practice with the organs of speech. It did not in this case, for scarce a fortnight had passed over, when the ring of her voice, while emitting sound, made the fact clear that though for all practical purposes as deaf as F. R., still as regards the pliancy of her vocal organs she was more fortunately situated than her school-companion. We knew from experience in Rotterdam, that in time she would be able to imitate words with greater precision, and that the tuition of her speech would cause us less labour and less careful deliberation. These expectations were not raised in vain.

It took little more than four months to make her pronounce the vowels, complex vowels as *i*, *oi*, *ou*, *you*, &c., and consonants, with clearness.

And notwithstanding that her tendency to close the nasal channel necessitated caution in the practice of *m*, *n*, *ng*, and *nk*, and enforced upon us the obligation to continue the exercises with these letters for a longer period than usual, after a lapse of nine months, she not only knew to combine them satisfactorily with all others, but could do so without the teacher's interference.

The exercises for labial instruction were the same as of F. R. The results showed again that from any part of the room, single letters, syllables, and words could be distinguished or understood, and that when in the open air, close by or at a distance, it was possible to interchange thoughts with her by uttering the words in a strongly-marked manner. It may be said then that the greater part of the first year was principally taken up in *preparing* this pupil, and that as soon as she was enabled to express her simple ideas by speech or writing, and could understand the thoughts of others by reading spoken or written words, the sole object of the following years would be the development of the mind. But as mechanical speech can be taught with exercises which have meaning as well as without them, it is natural that we chose those which were calculated to store the mind with names of useful objects; and it is evident, therefore, that the mental faculties even during the preparatory course were not altogether dormant. In this manner the youthful memory had been accustomed beforehand to retain a variety of names, long and short; a circumstance which was of great service when we undertook in the second year to instruct her in the art of reading and writing easy sentences. It would be tedious to enumerate here the various sets of exercises that were given to initiate the pupil in easy language, but it may be worthy of notice that the descriptions of pictures or events usually given to the deaf were read by the pupils in an audible voice, and that we repeatedly invited them to relate to us slowly and as distinctly as possible, whatever incidents they had witnessed on their way to school.

Thus they were encouraged to talk, the exercise of their powers of observation and reflection was most direct, and the opportunities for correcting their grammar and mode of articulation were manifold and fruitful.

All through the course of instruction, *reading* has since formed the principal feature in the daily studies of this pupil.

Much knowledge was stored up during the third and fourth year, by entering into the meaning of easy stories, descriptions of animals, short and simply written essays on articles of food, manufactures, &c. Later on, subject-matter was found in the study of topography, for which we drew up a series of lessons, framed in a manner that would draw the pupil's attention to space as defined by the house, by the immediate neighbourhood, by the village, and finally by the town and district. This brought her (and her companions) in a natural way to the consideration of public buildings and their history; which latter, however, was entered upon only in so far as it would serve our design to illustrate the meaning of the term, "history," as applied to Manchester, and the history of England. What other observations were made in thus examining the chief parts of a large manufacturing town one may readily guess. Ocular illustration aiding greatly to heighten the interest in, and the proper understanding of these lessons, the arrival of the hour known to be set apart for their initiation in the geography of the district (Lancashire) was met with a smiling countenance.

The geography of the British Isles has always been a favourite subject of this pupil, and since it is concluded she has shown no less pleasure in reading and committing to memory several of the noteworthy points presented by an outline-description of our interesting part of the globe.

With equal zeal has she been engaged during the last year in the study of the history of England, up to the time of the annexation of the principality of Wales. When she is now endeavouring to improve herself in any branch of instruction, it cannot be said that that branch exclusively engrosses her attention; for so much similarity of grammatical form and construction presents itself in written language, and so many kindred observations on various topics are contained in any book of simple composition, that its perusal is to her quite as valuable for the repetition of previously-obtained information, as for the acquisition of any fresh knowledge. Of what the friend of the deaf has to make a particular study, is the form of language in which knowledge may be clothed. The least misconception of a word throws them off their guard, and drawing conclusions from the context is a thing altogether unknown to nearly every one thus afflicted.

Constant practice in conversation, the reading of books whose style is not above their comprehension, habituating them to the use of the dictionary, and unceasing care in correcting their mistakes, are the only means, therefore, that can operate successfully to initiate them into the mysteries of a rich, refined, and complicated language.

We might dilate now on the great advantages this young lady derived from the assistance she received at home, but as this point will not be overlooked in the account of the next example, the observations there being also more or less applicable to this and the previous case, we shall conclude this description with a few notes on the subject of arithmetic.

Calculations with numbers form to the reasoning powers of the young deaf such a source of embarrassment, that this branch of their instruction demands from the tutor a more than average amount of patience and perseverance, and enjoins on him the obligation to give preparatory exercises with practical illustrations. Indeed this method has to be resorted to whenever the pupil is brought to a stop, which is by no means a rare occurrence. This pupil discovered her difficulties when she attempted to work examples like the following:—

Write in numbers six thousand and thirty.
Add together 198; 74; and 87.
Find the difference between 214 and 96.
Multiply 908 by 70, &c.

Problems similar to the two last could only be done after three years' schooling; and division presents difficulties of a nature that doubtless perplex many of the deaf of any age. Facility being obtained in the mechanical working out of such questions on a more extended scale, the useful practice of mental arithmetic was commenced. A few examples of the character of those which are given to her (and her class), twice a-week, we subjoin:—

1. Suppose a lady bought 7 yards of calico at 8*d.* a yard, and paid 60 pence. What had the shopkeeper to return to her?
2. Six children got 41*l.* from their parents and 7*l.* from their uncle. The whole was divided between them. What had each child to receive?
3. If John bought 9 marbles and Willie 5, how many marbles more had Peter if he had 17?

The following is a *verbatim* conversation held with this pupil while out on a walk.

Teacher. (With tablet in hand, searching for his pencil.)
Pupil. "Have you lost your pencil?"
Teacher. "No; I think not."
"Master M." (met on the road just before) "told me that his mamma has been to Scotland and Ireland, and will return this evening. Would you like to go there?"
Pupil. "I have been to Ireland—I should like to go to Scotland."
Teacher. "Why?"
Pupil. "Because I have never been there."
Teacher. "Where should you like to go, if you went there?"
Pupil. "The same as mamma went."
Teacher. "Yes—but where?"
Pupil. "To Glasgow, Edinburgh, Perth, and Lanark."
Teacher. "Has your papa not promised to take you to Scotland?"
Pupil. "Oh, yes."
Teacher. "When will he take you?"
Pupil. "Papa said, when I am 14 or 15 years old." (Laughing because the teacher wrote these sentences.) "Why do you write the same as I talk?" (Looking at the tablet.)
Teacher. "Because I want to remember what you say, and what

mistakes you make. Where will your mamma take you in the holidays, do you think?"

Pupil. "I do not know." (Interval.) "A. sent H." (two of her brothers) "a nice book, *namely* Longfellow's poems, because it was his birthday." (The confounding of *namely* with *named* or *called* will be observed.)

Teacher. "Did you see it?"

Pupil. "No. I think H. will show me next month."

Teacher. Show you what?"

Pupil. "Show me *it.*

Teacher. "Do you suppose you can read it?"

Pupil. "I think so."

Teacher. "But do you think you can understand it?"

Pupil. No.—"

Third Case.

J. M. A. is a boy, 11 years of age, and has been under instruction two years and eight months. His previous condition may be conceived from the appended certificate written by the rector of the village whence he came, and from the fact of his being able to utter half-a-dozen words, as "papa, mamma, bat," &c., in an indistinct manner and from remembrance of former times.

"Feb. 28, 1862.

"I hereby certify that J. M. A. has been well known to me for the last four years; that I have had many opportunities of observing him. He appears to have some degree of hearing, and a slight, though at present, very slight power of speech. I further consider him to possess considerable intelligence, but, from his defective hearing and speech, not capable of being instructed in the usual mode adopted with other boys."

Under these circumstances I need hardly remark that nature's tendency wanted but little of human art to re-establish the mechanical use of a faculty lost through a woful disease in infant age. Gaining the intelligent use of that faculty was a matter of time, because the organs of hearing were only sufficiently sensitive to be useful when acting in concert with those of touch; and oral sounds were not imitated by the single agency of the ear. The relatives of the boy and a private teacher had tried that experiment by shouting in the ear, but beyond the echo of the few simple words that were learnt as an infant, nothing could be taught. In cultivating the voice then, it was essential to keep two objects in view. One, to accustom the boy to depend upon muscular action, and to pay attention to the positions of the vocal organs; the other, to exercise his hearing, which latter is of great moment, when it be remembered that experience shows that hearing *when it presents itself to such a degree as was the case here*, seems to improve, if its sense be cultivated simultaneously with the practice to let the deaf child feel the vibration which sound causes on the top of the throat and elsewhere. One example will make this plain. Suppose the sound of the word "like" was made in a full

tone at the boy's ear (that one with which he hears the best) before instruction, he would perceive a noise but could not repeat it, but at present, when the word was called out aloud and close to his ear, he *would* be able to do so, for two reasons: firstly, because by practice his hearing may have become intrinsically slightly better; and secondly (and this we consider the main if not the sole reason), because he has learned to imitate the sound with the aid of the sense of touch, and was therefore sufficiently acquainted with its nature and its meaning to distinguish it from all others, when it reached the mind through the medium of the ear.

Nevertheless, the reader must not hastily conclude that the pupil would thenceforth be enabled to understand any word that is spoken loudly to him. Far from it. He can only do so when it is short, the meaning well understood, and the word pronounced by itself. When he has become more intimately acquainted with the various meanings of the majority of ordinary words, it may be expected that his hearing will be of greater practical utility, and it is sure that it will be a still more valuable support to his indispensable acquirements of "lip reading."

The results, then, of oral tuition with this and other children, induce us to express the earnest wish that the Directors of Institutions for the "Deaf and Dumb" (whatever their views on the method of articulation may be) will consider seriously when mutes thus circumstanced are introduced to them, whether or not it be advisable to have them educated according to the principle of dactyology,* inasmuch as these results clearly prove that instead of being capable of learning a few sentences, as some have presumed, they can be made acquainted with a whole language whilst they may be much benefited by a careful treatment of their impaired sense of hearing.

The mental growth of this pupil has been an object of great interest to his relatives and to his teacher, for the rapidity with which he has gained and is gaining grammatical knowledge and practical information is surprising—a fact which can only be explained by the laudable care his parents bestow upon him, and by the due attention they have paid to any friendly advice we have had to offer them. Explanations of words or sentences which slipped the memory after the time of instruction, were renewed, whilst others originated from conversation and literary occupation at home, so that the reasoning faculties were not merely usefully engaged during school-hours but profited him much after them.

The poverty in language which Dr. Kitto has called "the distressing dearth of matter in the letters and other writings of the deaf" and its cause, we pointed out to his parents, and it had the desired effect of making them still more determined to correct his errors, to keep up the greater part of what he learned at school, and to redouble their efforts to make him conversant with colloquial phrases and the comprehensive parts of any newspaper or children's book that seemed to interest or amuse him. The result is, that though his memory lacks much of its retentive power, he has acquired during the short time of

* Speaking or communicating with the fingers.

his instruction, a greater amount of language and general information than anyone would anticipate, who is well acquainted with the disadvantages of the deaf.

It would be difficult to estimate roughly the progress he has made in the ordinary branches of instruction, for although limits might be indicated in reading, writing, geography, and history, they could only be indistinct and unsatisfactory, arising from the circumstance that many new and valuable ideas are picked up by him from sources wholly apart from his regular course of study.

One of the most beneficial of these consists in the reading of the daily and weekly newspapers, as will be seen by the conversation which follows; which increases his stock of words and expressions by many valuable additions. The many events of the history of the day are the more attractive to him, because he easily discovers that the interest taken in them is not confined to himself. Conscious of that fact, he freely inquires about all that passes near and far, and will imperceptibly be led to the knowledge of that chain of current events by which life becomes much more enjoyable for one who is deprived of such a valuable treasure as the sense of hearing.

Of the powers of conversation and general attainments of this boy, the following dialogue between him and one of the Editors of this Journal will be an illustration. We three had been visiting the Brown Museum and a large ironmonger's shop together the day before, and the author of this paper took down the conversation, word for word. Nearly all that the boy had seen was quite new to him :—

Editor. "Tell me what you saw in the museum yesterday."

J. M. A. "I saw a rolling machine." (Pausing and reflecting.) "Not in the museum." (It was a garden roller he had seen in the ironmonger's shop.)

Ed. "I asked you, in the museum?"

J. M. A. "I saw a large skeleton of a large whale. I saw a beautiful crab; a common crab. I saw the tortoise; the American frogs; a balilla—large—a large monkey." (Meaning gorilla.)

Ed. "You must tell me the proper name of that monkey."

J. M. A. "Ape." (He had been told the day before that the gorilla was an ape.)

Ed. "That is not the proper name of the animal. Tell me the name of that large ape; not *Bal*illa."

J. M. A. "I cannot tell."

Ed. "You must try."

J. M. A. (Shaking his head after some reflection). "I cannot tell you the name of the ape."

Ed. "Do you read the newspapers?"

J. M. A. "Not always. Yes; at home."

Ed. "Do you know that a Frenchman brought many of those apes from Africa?"

J. M. A. "Yes."

Ed. "What is his name?"

J. M. A. "His name is Captain Grant." (Thinking and shaking

his head.) "Dr. Livingstone." (Reflecting again.) "No; I cannot tell you the name of the African traveller."

Ed. "I will spell it for you. D-u." (The boy repeated the letters.) "What does that spell?"

J. M. A. "Du."

Ed. "C-h-a-i-l-l-u."

J. M. A. "Challoo." (So he pronounced it.)

Ed. "Put the two together."

J. M. A. "Du Chaillu. I have never heard of that name."

Ed. (After waiting a little). "What name?" (The boy repeated it.) "He first brought the gorilla into England. Now go on; tell me what you saw."

J. M. A. "I saw a fish. Its name is jack. Do you know?"

Ed. "Very likely; but I did not see it. Go on."

J. M. A. "I saw three prawns; they are very pretty." (They had been looking at the aquarium.)

Ed. "Were they dead?" (He did not read the word "dead" quickly from the lips.) "Were they alive?"

J. M. A. (Nodding). "Alive."

Ed. "What were they moving in?"

J. M. A. "They were moving their legs."

Ed. "You do not understand me. *In* what did the prawns move?" (No answer.) "Was it in a teapot?"

J. M. A. (Laughing). "No; in a glass box full of water."

Ed. "Tell me what more you saw."

J. M. A. "I have seen——"

Ed. "Wrong!"

J. M. A. "I *saw* an artificial town, in down-stairs" (correcting himself)—"in the lower room."

Ed. "What do you call a small town made of wood, and put under a glass case?" (It was the model of Liverpool.)

J. M. A. "There is no name." (Meaning on the town; he did not see the name.)

Ed. "What do you call a small engine?" (Showing the size of a model with his hands.)

J. M. A. Shook his head.

Ed. "A model." (He had never heard the word before, and it was therefore written down for him.) "Tell me what else you saw?"

J. M. A. "I saw a small ship, which bears three masts."

Ed. "Also a model."

J. M. A. "Yes; a model."

These are a few examples of the tuition of the deaf by "lip-reading" and articulation instead of by dactyology, and we hope the day is not far distant when the former will supplant the latter wherever it is practicable.

PETROLEUM:

Its Importance, its History; Boring, Refining.

By Henry Draper, M.D., Professor of Natural Science in the University of New York.

In a country so large in area and yet so sparsely settled as the United States, the tendency of men is to become extremely practical, and to neglect things which do not seem to have an obvious bearing on the production of wealth. Heretofore the attention of a great part of the community has been directed to a peculiar agriculture, in order to extract the treasures of the soil as quickly as possible. As has been well said, we commonly affirm that we are devoted to agriculture. We count up the preponderating millions who spend their lives in that pursuit. We say that we are a producing nation. It is not so. Agriculture has never been practised in the United States. We are miners not farmers. We clear land and put a new field in tobacco. In due season we send the produce to market. We put the same crop in the same land a second year; but if we try it a third or fourth we fail, for the tobacco will not grow.

How is this? The plant has exhausted the soil of one of its ingredients necessary to fertility—its potash. Now in the absence of that substance, which is essential to its very constitution, it can no longer come to maturity. What, then, is the difference between the Virginian who has been setting tobacco plants to collect the potash from his land, and the Californian who has been employing men to wash his soil for gold? Both have sold or sent to other countries the inorganic material that was their source of wealth. Both have impoverished their estates. Both are miners.

Consider what has been going on for the last two centuries along the whole Atlantic coast, for what has been said is only a forcible presentment of what is going on everywhere. It holds good for the cotton, the wheat, the corn. From the shore line there has been an onward march up the gentle incline of the continent. Strand after strand of fertile soil has yielded up its wealth. The front of the vast phalanx has already touched those regions where the rains are uncertain, and therefore the seasons unreliable. Beyond them is the untrodden desert.

A knowledge of what is thus approacing has caused much attention to be devoted to the development of the other mineral resources of the country. Gold, silver, mercury, iron, copper, coal, and a multitude of other valuable substances. are being continually detected in places in which their existence was previously unknown. Among these discoveries, that of Petroleum is without doubt the most remarkable. Although I have already made mention of a few facts in its history in a former article, the importance of the subject is sufficient apology for referring to it more in detail, and for presenting the following account derived from various American sources.

Four years ago, Petroleum may be said to have been generally unknown in America; now it is one of the most important articles, both of home consumption and foreign exportation. Its value is not less than one-fourth of that of the cotton-crop, the best estimates setting it down at 15,000,000*l.* sterling per annum. A statement of the facts known about it should be of especial interest, not only in England but also on the Continent, because if bored for in those localities in which it is now known to exist, or in which signs may be detected, the same result may be attained as in Pennsylvania. It is no exaggeration to say that its presence is more desirable than that of gold. What Californian or Australian can rival John Steele, of Oil Creek Valley, who is said to derive 150,000*l.* a year from mines on his property?

The existence of Petroleum, and its use as an illuminator, have been known for centuries, not only in the East, but also in Europe. The Greeks and Romans were acquainted with it, a spring in Zante being referred to by Herodotus, and according to Dioscorides, the oil was collected and burned in lamps by the inhabitants of Agrigentum, in Sicily. Some of the places at which it has been found are Bakoo in Georgia, on the borders of the Caspian, "at the foot of the Caucasus fountains of naphtha put fire into the hand of man," Rangoon in Burmah, Amiano in the Duchy of Parma, Saint Zibio in the Grand Duchy of Modena, Neufchatel in Switzerland, Clermont in France, some points on the banks of the Iser, Gabian, a village near Bezières, Tegernsee in Bavaria, Val di Noto in Sicily, in Zante, Gallicia, Wallachia, Barbadoes, England, the United States.

At Amiano in Italy, Petroleum has been extracted for two hundred years by merely digging pits in the ground and collecting the fluid that oozed from the soil in vessels at the bottom of the pits. No attempt has been made at purification, the various kinds being merely mixed together to secure a uniform product. The supplies procured from this source have furnished the means of lighting the cities of Parma and Genoa. At Bakoo large quantities of inflammable gases and liquids rise to the surface of the ground. They are found over a narrow tract of twelve square miles in extent, the strata being of porous argillaceous sandstone, belonging to the tertiary period, and full of fossil shells. The oil is collected in the same way as in Italy. That obtained from the central parts of the district is of a faint yellow tint, while toward the sides of the tract, it gradually passes through shades of green and brown into asphaltum. The quantities annually collected are, according to M. Abich, valued at 120,000*l.* Over large districts in Persia, no other illuminating material is used. The phenomena it presents cause the region to be called the Field of Fire, and made Bakoo the sacred city of the Guebras or Fire-worshippers. The Rangoon district on the Irawaddy has also produced enormous quantities of Petroleum. For an unknown length of time the Empire of Burmah and a large part of India has been supplied from it with oil. According to Syme (Embassy to Ava), the number of wells exceeds 520, and the annual yield is 400,000 hogsheads. Another authority states that each well yields annually 173 casks, of 950 pounds. The oil is used for burning, preserving timber against insects, and for

medicinal purposes. An attempt has been made in England to use it as a means of forming paraffine candles.

In America, Petroleum was known to the Seneca Indians, who have a tradition to the effect that its existence was revealed to one of their chiefs in a dream by the Great Spirit. He was directed to proceed to a certain spot, where he would find a liquid, oozing from the earth, a healing balm to his tribe. Even at this day "Seneca oil" can be procured in the drug shops, and is supposed to possess virtues in skin diseases and rheumatism. Day, in his "History of Pennsylvania," states, that the Indians esteemed this oil very highly, using it to mix with their war paint, and also for religious purposes. He quotes a letter from the Commander of Fort Duquesne to General Montcalm, in which an assembly of Indians, by night on the banks of the creek, is described. In the midst of their ceremonies, the oil that had collected on the surface of the water was fired, and simultaneously a shout of triumph burst forth, that made the hills re-echo again. The scene reminded the writer of what is related of the rites of the ancient Fire-worshippers.

When the whites occupied the land in Pennsylvania, from which the Indians had been in the habit of procuring this oil, they found excavations which had been used for collecting it as it came to the surface, and some of these still exist on the Rynd farm, near Oil Creek. The oil may be gathered by spreading woollen cloths on the surface of the water, and wringing them when saturated. It was not, however, till long after, that the Petroleum oil became generally known as an illuminator, and only since 1859 have wells been sunk with the specific object of obtaining it. The first of these was dug under the auspices of a New Haven Company, by Colonel Drake, who succeeded in striking oil near Titusville, Crawford County, Pennsylvania, and making fortunes both for himself and his friends. These fortunes have been far eclipsed by those since accumulated in the same region, a great many persons having become millionnaires.

Previously to Drake's operations, however, in 1819, in boring for salt on the Little Muskingum river, in Ohio, one of the two wells sunk discharged vast quantities of Petroleum and gas, in an explosive way, and although Dr. Hildreth states that it was in some demand for lamps in workshops and manufactories, and predicted that it would be "a valuable article for lighting the streets of the future cities of Ohio," yet for more than thirty years it did not come to be used in this way, and might have remained still longer comparatively unknown, had it not been for the attempted production of illuminating oils from the slow distillation of bituminous shales and coal. It was the application of the methods of purification thus learned, that enabled Petroleum, or rather Kerosene, one of its distilled products, to replace the animal and vegetable oils previously used.

The method of working to get oil is as follows:—The land is either bought or leased; in the latter case one-half of the soil goes as a royalty to the owner. An engine and machinery have then to be brought to the site. The latter contains, as an essential feature, a walking beam, of about thirty inches stroke, to communicate motion

to the drill. An iron pipe, six inches in interior diameter, and one inch thick, is driven down by a pile driver till it reaches the solid rock, a distance of perhaps sixty feet. This tube is then freed from its contents by a sort of pump, a hollow piston, six feet long, with a valve at the bottom, opening upwards. As soon as this part of the operation is completed, the drilling of the solid rock is commenced. The drilling tool is a solid rod, weighing 800 lbs., and is thirty feet long. It is attached to a rope an inch and a half in diameter. The bit which forms the end of the drilling tool is three inches and a half wide. After it has perforated the rock five or six feet, it is replaced by a "rammer," a cylindrical tool four and a half inches wide across the face, intended to make the hole round and smooth. At intervals, the pump above mentioned is inserted to clear away the *débris*. The strata passed through in Oil Creek Valley are, according to the phraseology of the miners: first, slate rock, 100 feet thick; then sand rock, perhaps 30 feet thick; then soap rock, 125 feet thick; and after that a second sand rock. This may vary from 10 to 25 feet. After going through another slate and soap rock, the third sand rock is reached at a depth of 430 feet. In this the oil is found in the largest quantities. Occasionally the oil is found in the second sand rock. After the well is bored a short distance into the third sand rock, it is lined with two-inch gaspipe, and if the contents are not expelled spontaneously, it is pumped to ascertain whether oil has been reached.

It not infrequently happens that a boring proves unsuccessful after all this labour, for it by no means follows that, even if in the neighbourhood of a well that is already yielding, it will strike a reservoir. There is no resource under such circumstances but to abandon it and sink another. On the other hand the oil, if found, may rush up with the greatest violence in wonderful quantity, and may even carry away the derrick and other parts of the boring machinery. Such wells may eject a thousand or more barrels a day, and then suddenly cease to flow. It is necessary to resort to pumping in that case, and to be contented with a more moderate product of from five to twenty barrels a day. Water saturated with salt is not infrequently struck, but this, though highly valued in other places, as at Syracuse, in New York, is here regarded as of no avail, and allowed to run to waste. The value of the fortunes suddenly acquired, is in many cases entirely unknown to the owners. A correspondent of the 'Herald' states, that he "was paddled across the creek by an oil prince, aged fifteen, heir to a million, coatless and hatless, and with but one suspender."

The oil regions are being rapidly penetrated by railways, the capital being to a large extent furnished by foreigners. It is expected that there will be continuous communication throughout the most populous part before spring. The value of the soil in the neighbourhood of Oil Creek, that is, of a strip on each side two miles wide and twenty miles long is estimated at 50,000,000*l.* sterling. Four years ago it was worth about 1*l.* an acre. Some farms valued at 400*l.* before the excitement, have since been purchased at prices varying from 120,000*l.* to 200,000*l.* and are now rated at a much higher amount.

The expense of boring a well, including a ten-horse power engine,

engineers' and other men's wages, tools, tubing, coal, &c., is about 1,200*l.* In addition, a certain allowance must be made for accidents, such as breaking of the boring tools, and difficulties of extracting it. The profits made on the oil are very large, the cost of a barrel of forty-one gallons, including freight to New York, being about 3*l.*, while it may sell for nearly 4*l.* The crude oil is worth, at the wells, about 1*l.* 10*s.* a barrel. Of course these prices fluctuate considerably. It is now proposed to conduct the Petroleum in gas pipes to the termini of the railroads, so as to lessen the expense of cartage, which is about 6*s.* a barrel at present rates. These pipes will have to run distances of from seven to twelve miles.

The amount of oil sent abroad is continually increasing. Antwerp alone having taken, in the first eight months of 1864, 135,000 barrels of refined and crude. In New York city, a regular Petroleum Board has been established, which is attended by four or five hundred dealers in the article. Up to the present, there have been formed two hundred and fifty companies for the working of these borings, representing a capital of 30,000,000*l.*

The use of Petroleum, or rather certain of its ingredients, as a fuel, has been proposed in the case of steamers making long voyages. The advantages are, of course, sufficiently obvious, decreased bulk as compared with coal, absence of ash, mobility. On the other hand, there are the difficulties of contriving a suitable furnace, and the danger from fire. At the oil wells themselves, for instance, in the Downer Refinery, they are, however, using the refuse of distillation for heating the necessary apparatus, and some of the pumping engines generate steam by the aid of the combustible gas that is so commonly associated with the Petroleum, it only being necessary to conduct it by a pipe from the tanks in which the oil accumulates to the furnace of the engine.

Besides the discoveries of Petroleum in Western Pennsylvania, to which the preceding statements principally refer it has also been found in Western Virginia, North-western New York, Ohio, Central Kentucky, Michigan, and Canada. In Michigan, boring is now being conducted at "Burning Spring," a place on Lake Michigan, so named by the Indians, and with every prospect of success. In Western Virginia, the wells do not require to be bored so deeply as in Pennsylvania. In Ohio and Virginia, the Petroleum is found in the coal measures, and the wells have often to be sunk through these into the sandstones and slates below, before becoming productive. In North-west Pennsylvania, and in New York, the wells are entirely outside of the coal field, and so remote, that one can hardly imagine any connection between the two. The strata in which the oil is found dip south, and pass below the coal-measures at least 500 or 600 feet, the nearest coal-bed to the more northern springs occurring on the tops of the highest hills, thirty miles distant. The oil wells in this group are bored through alternating layers of shales and sandstones, and an occasional layer of bluish sandy limestone. The next group, below, is that known as the Hamilton Shales in New York, and in Ohio as the black slate. Dr. Newberry considers this the source that affords the

Petroleum. It contains much carbonaceous matter, and is supposed by him to be sufficient for generating the supplies forced to the surface by the conjoined pressure of water and carburetted hydrogen, furnished from the same material. It is from these states that the oil springs of Canada West issue, and these are far distant from the coal formation.

The origin of these hydrocarbon compounds is, however, still a vexed question. That they are the product of the fermentation of either vegetable or animal substances, is admitted on all hands. In the United States there is no evidence to contradict the supposition that they result from the bituminous fermentation of vegetable matter; but in Canada, where they are found in the lower Silurian limestone, they have been suspected to be of animal origin. "The cavities of large orthoceratites have been found filled with Petroleum, but so fetid as to be most offensive." As to the duration of the supply, there is, of course, no certainty. The Rainanghong wells in Burmah have flowed for ages; and some of these American wells have resisted the steam pump successfully for four years. If Petroleum is regarded as having passed through the intermediate stage of an association with bituminous shale or coal, and having undergone a process of distillation, the observations of Professor H. D. Rogers as to the greater and greater decrease of volatile matters in the Appalachian coal field, as you come from the west toward the east, would be of great importance. He states that at the western limit, where the strata are still horizontal, the proportion of volatile matter may reach forty or fifty per cent., while on the eastern side, in the boldest flexures of the Appalachian chain, where the strata have been actually turned over, we find the coal to contain only from six to twelve per cent. of bitumen, thus becoming a genuine anthracite. Sir Charles Lyell, in examining these observations says, that "there is an intimate connection between the extent to which the coal has parted with its gaseous contents, and the amount of disturbance which the strata have undergone. The coincidence of these phenomena may be attributed partly to the greater facility afforded for the escape of volatile matter, where the fracturing of the rocks had produced an infinite number of cracks and crevices, and also to the heat of the gases and water penetrating these cracks when the great movements took place which have rent and folded the Appalachian strata.

Professor E. W. Evans, of Marietta College, has recently published the result of his investigations on oil wells in the 'American Journal of Science.' He thinks that the principal supplies of Petroleum are not diffused between the planes of stratification, but are collected in cavities more or less sunken in the strata, where it is less liable to be carried away by running water. The places in which it is sought for with most prospect of success are those where there are marks of disturbance and displacement of the rocks. The cavities have been caused by erosion or uplifts, and are usually of slight, horizontal extent, so that two neighbouring wells but rarely strike oil at the same depth. Besides, the drill, as it enters the oil cavity, sinks, variously, from four or five inches to as many feet, sometimes sticking

fast as if between the oblique sides of a narrow fissure. He shows that from certain facts connected with their intermittence and occasional interference with one another, the wells are often connected by channels more or less free, running, sometimes along the strata, sometimes across them. The productiveness of a well depends upon its entering either one of the main reservoirs, or some of its important connections. Every collection of oil is accompanied by varying quantities of gas and water, the gas being above and the water below. The material yielded by a well turns on the part of the cavity entered. If it is pierced near the top, gas first escapes with violence, and subsequently, as water enters such cavities readily, the oil is floated to the end of the boring, and may be pumped out. If, however, water enters more quickly than the oil is removed, the latter may be floated to the higher parts of the cavity, and be out of reach till the former is pumped away. If the middle parts of the cavity are tapped, oil rises at once in the well, forced up by the gas at the upper part, and may be thrown out from the mouth of the well. This will continue till the pressure of the gas is equal to the hydrostatic pressure of the column of oil, when pumping out must be resorted to. If the lower parts of the cavity are tapped, water at first will be the only product; but if this be pumped out, oil will at length be reached. It will rise in the tube one-fourth higher than the water, on account of its less specific gravity, ·816, and thus a very unpromising well may prove productive. The Shattuck well on the Little Kanawha had to be drained of water with a steam pump for two weeks before oil was obtained, but after that it yielded abundantly.

In addition to this class of wells, which seem to consist of but one isolated cavity, and which may be permanently exhausted, there is another class in which the oil is more or less quickly replenished. These are distinguished as intermittent wells, and where one is found, it is a sign that there are many oil cavities near together in the same locality. If it yields copiously for many months in succession, without diminution in quantity, or increase in the intervals of yield, the rocks in its neighbourhood may be presumed to contain rich supplies of oil that may be directly reached.

On Oil Creek, in Pennsylvania, most of the oil is found in the same stratum of sandstone, the rock seeming to be perfectly honeycombed with Petroleum cavities. The action of many of the wells is as follows:—When oil is entered, the gas begins to raise it over the top of the boring, increasing gradually in force till it projects perhaps forty or fifty feet into the air, then alternately it increases and diminishes in force at regular intervals. These variations in the force of the gas, or "breathings of the earth," as they are called, are explained by supposing that, as the tension of the gas is relaxed by the removal of oil, the gas and oil from other cavities rush in through the slight fissures, until the maximum tension is again reached. A well may alternate two or three times in a day, or as often in an hour; it may almost cease to yield, and then suddenly give out more than ever before, owing to the bursting in of a new supply from some untouched source, solicited by the decreased pressure.

Professor Evans does not think that in any case the oil is raised to the surface by the direct pressure of water, the heads of which are higher than the issue, as Artesian wells are said to be produced, but inclines to the belief that the flow is due exclusively to the pressure of gas accumulations. In support of this, he shows that gas always escapes from spouting wells, and that a current of water would be sure to float away the oil, the springs in such vicinities being tainted in this way. The finding of oil in association with water is not, however, a reliable sign of the presence of oil below, because it may have come many miles; but the presence of gas, which is much less likely to be transported downwards and to a distance, is regarded as a valuable indication.

Petroleum of different localities varies greatly in character. Ordinarily of a greenish colour, it may present greater or less degrees of opacity; it is sometimes reddish; as it occurs in nature it is of no fixed composition, but consists of various hydrocarbons holding in solution paraffine, and more or less bitumen or asphaltum. The appearance of the oil turns on the proportion of these solid ingredients. As the amount of asphaltum increases, the oil becomes more and more like tar, eventually passing into a substance possessing so little fluid matter as to be solid at ordinary temperatures. This is its condition as found in Tar Lake, in the island of Trinidad, and it is then suitable for making pavements or hydraulic works, or for replacing pitch. The refined oil has a characteristic smell, which is not entirely removed by the usual process of purification, though, by standing several days over an alkaline solution and freely exposed to the air, it may be caused to disappear. The best American oils are those from Oil Creek, which mark 46° on Baumè's hydrometer; those from Mecca have a density of 26° or 27°, and will not flow when cold. A new method has been recently introduced for testing the illuminating oil, instead of depending on the hydrometer alone; it consists in observing the temperature to which the fluid must be raised before it can be set on fire by a flame. That is preferred which ignites at from 100° to 120° Fahr. The proportion of light oils suitable for burning in the best Petroleum is sometimes ninety per cent.; other specimens will not yield thirty per cent. The heavy oils parted from these during distillation are only useful for lubricating, and even then require the admixture of animal oil to give body. The paraffine which remains behind with the heavy oils is separated by the aid of cooling mixtures and pressure, and exists in very different proportions in different samples. The average yield is said to be about one pound from four gallons of Petroleum.

The processes for rectification of Petroleum do not differ greatly from those formerly used for crude coal oil, produced from the distillation of bituminous shales, &c. This latter operation is an old one, having been patented in England in 1694 by Martin Eele, Thomas Hancock, and William Portlock. The discovery does not seem to have been attended by any practical consequences until the present century, when the whole subject of the effect of distillation at high and low temperatures, not only of these but of animal and vegetable substances, was thoroughly

investigated by Reichenbach, and many new products among the paraffine discovered. Christison, in England, also discovered paraffine about the same time. Afterwards the matter attracted great attention in France, and in the patents taken out by Selligue and others in that country, from 1834 to 1845, full details of apparatus, which has not been essentially improved up to the present day, are to be found. In the patent of March 19th, 1845, Selligue enumerates the products of distillation as,—1, a limpid whitish volatile oil, useful as a solvent, and sometimes called naphtha; 2, a straw-coloured oil suitable for burning in lamps with a double current of air; 3, a heavier oil for lubricating; 4, a red colouring matter; 5, paraffine; 6, a grease composed of paraffine and oil; 7, a black pitch; 8, an alkaline soap; 9, sulphate of ammonia; 10, ammoniacal fertilizing liquors; 11, sulphate of alumina. His plan was to treat the crude coal oil obtained from the retorts in which the bituminous substance was distilled with a strong mineral acid, and agitate it thoroughly. This caused the tarry matters to subside with the acid. The slight proportion of acid remaining with the oil was neutralized by an alkali, which caused another precipitate of tar and colouring matter. The oils were then separated from one another by fractional distillation.

In England, and also in America, the introduction of coal-oil distillation is due to James Young of Glasgow, whose attention was attracted to the subject by the exudation of Petroleum from a coal mine in Derbyshire. He subsequently found that the Boghead Canal was the most suitable mineral for the manufacture of coal oil, and in 1854 extracted at the rate of eight thousand gallons a-week, or 100,000*l.* worth per annum. From England the manufacture extended to the United States, Young having patented his process in both countries, the intention being to use the Boghead Canal of Nova Scotia, or some similar material from the West. The best specimens of the Boghead Canal were found capable of yielding a hundred and thirty gallons of crude oil, or seventy-five gallons of refined oil per ton. Many varieties of coal found in Kentucky and Ohio would produce nearly as great an amount. In 1860 the total number of manufactories in the United States was more than sixty. Of course the discovery of the Petroleum deposits has entirely destroyed this branch of industry. Nature can distil more cheaply than man.

The success of coal distillation turns on using a temperature not high enough to produce gaseous matters, and yet sufficiently high to drive the oil over. For this reason the best French retorts were cylinders which were caused to revolve slowly over the fire. The volatile matters make their exit through one of the axles upon which the cylinder revolves. The temperature needed is less than a red heat. Two and a half tons of coal, which is the amount that can be employed at a time in a retort eight feet long and six feet in diameter, may be distilled in six hours. The apparatus is liable to the objection that much of the content is reduced to dust, which escapes with the vapours and demands additional means of purification. The vapours are condensed in iron cylinders, where the water and oil are separated, and the gases escape either into the chimney, or are led into the fire under the retort.

The crude oil thus obtained is purified in the same way as ordinary Petroleum. It is re-distilled with increasing temperatures, 600° or 800° being eventually reached, in order to drive over the paraffine. About ten per cent. of impurity, including a very dense coke which is afterwards used in the fires with anthracite, remains in the still. It is next subjected to the action of five or six per cent. of sulphuric acid in vessels of three thousand gallons' capacity, called "agitators." After coming to rest the impurities settle to the bottom, and they are then drawn off and the oil washed with water, which in the course of a few hours is withdrawn. In the same way it is treated with potash or soda lye, and is then ready for the final distillation which separates: first, a very light oil; then, the illuminating fluid; then, the heavy lubricating oil; and, lastly, those parts which contain paraffine. The best illuminating oil is that of a light yellow colour, although the perfectly clear and colourless specimens are more valuable commercially.

A suitable vessel for transporting Petroleum has long been a desideratum. In the neighbourhood of the Burmese springs there are places where earthenware vessels especially adapted to the purpose are made in immense quantities. An ordinary barrel, although tight enough for other liquids, fails to prevent leakage of this very penetrating fluid. It is said that a barrel filled with naphtha will empty completely in two months. The escape of Petroleum in its journey from the wells to New York city, amounts to ten per cent. For transport across the ocean tanks lined with zinc have been used, to avoid the loss, some of the earlier packages sent having entirely discharged their contents. A recent patent claims to render the wood entirely impervious, by soaking it on the inner side with soapsuds, and coating the outside with boiled linseed oil containing drying materials. Iron cylinders have also been proposed.

These are some of the facts known concerning this singular substance. They have been related because of the extreme importance that it has attained as a source of wealth, and the comforts it has brought into domestic life. It has also ministered to the luxury of the times in adding to the number of the beautiful dyes produced from similar hydrocarbons—"Humboldt" and "Azurine" shades of blue, and "Rosina" having already been discovered in a refinery near the wells. It has entirely displaced whale oil, and has struck a fatal blow at the prosperity of the seaport villages of New England engaged in the whale fishery. The dangerous compounds of turpentine and alcohol—camphene, burning fluid, &c.—have been driven out of use by the cheapness, non-liability to explosion, and steady white light of this the best of all illuminators, gas alone excepted. Europe has coincided in this opinion with America, as may be seen by referring to page 521 of this Journal for July, 1864, where the export for 1863 is stated at 28,000,000 gallons. One firm has received an order to the value of 20,000*l.* from Russia, for the lamps in which it is burnt. The illuminating oils, too, have great detergent properties, and enable a person to remove many impurities, such as grease and metallic dust from the hands, when other means have failed entirely. For this reason some manufacturers incorporate them

with their soaps. Optically, they are interesting in not being exceeded even by sulphate of quinine in the fluorescent phenomena they present.

One development more is alone required to complete our indebtedness to these distilled products of bituminous fermentation. It remains to bore for gas to light great cities. In China this has already been done, and never-failing supplies are said to have been secured from wells three thousand feet deep. In one case, too, in the State of New York has the same result been reached. There must be prodigious supplies of oil and carburetted hydrogen locked up somewhere to the east of the great coal-fields of America. It should be remembered that, under a large part of the sixty thousand square miles where these deposits exist, only anthracite is found, the volatile matter having escaped.

ON METAL MINING.

By Dr. R. ANGUS SMITH, F.R.S.

ON our first visit to a mining district, we passed near a manufactory of blasting-powder. In a day or two an explosion occurred in it; much of it was destroyed; two or three persons were killed—young girls, if we remember well. There were only few persons at the works at the time. The neighbours informed us that the manufacturer had discovered a safe mode of making the powder, and that this was the third explosion that had taken place in two years! We did not inquire into the truth of these latter statements; as to the first, the newspapers gave the half-forgotten details.

We entered a mine, one of the higher class, and descended in a skip with a mining captain, who certainly inspired respect and confidence. We arrived below safely, and again rose in safety. The motion was remarkably easy, or rather quite imperceptible. We sank a thousand feet in three or four minutes; but we could not forget that our heads were uncovered, and that the slightest fall from the top or sides was sure destruction to us. Next day or nearly so the rope or chain, we do not know which, of a similar and neighbouring skip broke, and two men, packed together as we had been, were dashed to the bottom.

Our skip had a safety-catch. Had the one which fell? We cannot say. We entered Botallack mine. This journey was made in a char-à-banc of iron, which rolled down an inclined plane; and whilst we lay swathed in white flannel, and with candles in our hands, rushed through the hardest rocks, against which we were in constant danger of striking by the mere act of holding up our heads. Our candle went out, and we were left nearly in darkness. Captain James retained his light, but it was only enough to show how dark and hard-looking the projecting rocks were that threatened us as we rolled rapidly down under the sea. We came up safely; the patent catch was in order.

lest any accident should happen. We met a gentleman skilled in mines, and described the journey. "You actually went down," said he, "supported by a chain with single links? I would not have done it." We shuddered at the thought of one link among the hundreds being unsound, but then thought of the safety-catch. After we had left the district, nine miners went down in the same carriage with the support of the same link-chain and safety-catch; that one feeble link gave way, and all these men were killed!

There are other ways of descending mines; and we inquired as to the ladders. They were said to be 15 feet in length, each with a little projection for resting on. On close inquiry we found that this projection was not always placed, but the ladder simply continued to at least 60 feet, and that strangers sometimes, in the very midst of their ascent, would become transfixed; incapable of moving in any direction. For a moment they pictured to themselves their real position, which was that of standing on a ladder four times higher in the air, than St. Paul's ball and cross. The darkness hides this terrible fact, but the keen imagination sees through the rocks, and the result is the same as in the light. Probably no man could make the journey daily if he saw such a depth below him; darkness makes him appear to be rising only a few steps, although these may be often repeated. The mind must conform itself to the physical darkness, and not trouble the feelings by throwing a light on the scene, which, although purely that of thought, is almost as dangerous as would be the sunlight.

There are various kinds of stairs; some, when the inclination allows it, are merely boards with cross pieces to prevent slipping. These are often easily ascended, but in coming down there is much difficulty felt. We fear that in this country there is less attention paid to having railings as a support as well as safeguard. Along the footway there frequently runs the drawing-shaft, where the rough ore is drawn rapidly in boxes, out of which pieces frequently fall. When the shaft is confined, spiral stairs have been formed, but we do not receive information* on this subject. To mount a spiral stair in an old tower much above 100 feet high is fatigue enough for most persons, if it is not also productive of giddiness.

Another mode of descent is by the *man-engine*, which is a novelty to most men, although it is thirty years since Dörell invented it, in the Harz, and used it at Spiegelthal. We like to commemorate the names of inventors, and should have preferred to call this a "Dörell," if man-engine had not been so appropriate.

This ingenious invention had a most miserable appearance at first. To make the descent by it we were led to a small, broken-down hut, standing apparently alone Inside of it were several miners, with their candles in their hands. The candle is held in soft clay, which serves as a candlestick. It is extremely flexible, takes every form, and clings

* This refers to the Report of the Royal Commission appointed to inquire into the condition of all mines in Great Britain to which the provisions of the Act 23 & 24 Victoria Cap. 151, do not apply, with reference to the health and safety of persons employed in such mines, 1864. The pages refer to the epitome of evidence.

THE "MAN ENGINE":
For the descent and ascent of miners.

to a wall, which, however perpendicular, holds this candlestick as securely as a table. Seats were placed around the walls, and in a corner stood a beam four or five feet high. On this beam, and on a level with the floor, was a board 14 inches square, filling up the greater part of a hole which was in the floor. A man stood on this board and held by the beam; the whole went slowly down, and the head disappeared under the floor. Looking down there was an endless abyss, and small lights glimmered in the darkness. We took our stand on the board, and holding the beam descended. After going 12 feet the beam stopped. and our careful conductor said, "Step to the left." We stepped to the left, and stood on a board which was fixed to the side of the shaft, when the beam and the board on which we had previously stood rose up 12 feet to its first position. This brought another step, to which we passed, and the beam and step now went down other 12 feet, and we again stepped to the left and stood on a fixed spot. We had now descended 24 feet, and by constantly doing this arrived at the bottom.

In the plate (Fig. 1) the left-hand man has just got off the man-engine—he is going down; the right-hand man is stepping on—he is going up. By this means the same machine allows one to ascend and another to descend. There is the footboard every 12 feet on the moving-rod, which reaches the whole depth of the shaft, and at the same intervals of twelve feet there are fixed standing-points right and left. At Dolcoath this machine goes down 220 fathoms. Every two fathoms you must step on and off the engine, equal to 220 steps. There may be a man on every step from the bottom to the top. Strangers are taken down in about forty minutes, making a step every eleven seconds; but the usual time is about twice as fast, or one in six seconds. There is an iron handle by which to hold on to the beam This is seen in the plate (Fig. 2), which shows the side-view of a man on the man-engine. The same number of steps is made upwards, making 440 in a day. Ladders with steps 10 inches apart would, with little inclination, require fifteen times more steps, or 6,600 steps for the same depth. In addition to this, the weight of the body must be drawn up and carefully balanced by the skilful and powerful use of hands and feet. When men come up by the ladders they are fatigued according to the depth, and painful accounts are given of some who sink down in dangerous exhaustion at the moment of coming to the surface, or fall from destructive heights. The men shoot out of that bare floor head-foremost in the dingy hut as cool as when they went down; perhaps too cool, for the shaft has a good deal of draught. At any rate they are not fatigued.

The man-engine is certainly capable of being made most agreeable. At the time of its origin in the Harz mountains it was a much more dangerous affair, and even now it is not permitted to novices. Here we have heard of men and of boys falling down and being crushed. There is a most remorseless grinding motion, and attention must not relax for a moment. The landings are sometimes cut in the rock, and the muddy rock is slippery—horrible thought. Sometimes they are near the platform for a ladder-way which goes along side, and the

opening for the ladder seems to be the only spot on which you can step ; you must look carefully. Once we were struck behind on the hard rim of the hat ; the rock itself had done it, and we were thereby informed that we must keep the head close to the beam, and not stand quite so much at our ease as the men do in the plate. At another time we were struck on the right elbow, and then on the left, and thus with authority informed that we must keep from the sides. These are all evils easily remedied. The hard rim of the hat is a great protection to the head ; this is the cause of its constant use in mines, a lesson to those who too severely depreciate our common head-covering which has saved many lives.

We have shown the single man-engine. The double one has no steps or platforms on the rocks. There are two rods with steps, exactly like that seen in the centre of Fig. 1 and on Fig. 2. One faces the other : when one falls, the other rises. The man leaps on the steps, not exactly as it passes by him, for it stays an instant to reverse the motion. We may go in this way at double speed. There is one put up at Mariemont, in Hainault, by M. Warocqué, which seems to give greater protection to the men, who are not brought in contact with the side of the shaft. The mechanism is ingenious, but need not be described here.* The price of this engine, steam engine included, was 20,000 fr. for 228 metres ; 32,000 for 600 metres ; say 800*l*. for 114 fathoms, or 1,280*l*. for 300 fathoms. A fathom is not quite two metres.

Advantage of the man-engine.—Mr. Croch says, " A man was working in Wheel Reeth in a very close end, and disease of the chest was coming on ; he went to work where there was a man-engine and recovered. He and others also recovered much more rapidly than men who were put into better air, and still did not use the man-engine."

Captain Stevens says, " Before we had the man-engine, we could not get men above twenty years of age to go down to the bottom of our mine." Now there are men up to sixty.

Captain Daw says, " They would rather stay down two hours than climb up from the bottom of the mine." They get more experienced men now, and fifteen per cent. more labour.

Captain Stevens considers that in all mines a saving of a quarter is made by the engine ; in deep mines still more, in shallow mines less. Others consider that a man-engine will not pay itself unless the mine is 100 fathoms deep.

Objections.—The objections to the man-engine are its expense, being ill-fitted except for well-established mines ; that it demands the constant attention of the men ; if they make one false step it is fatal. Is human nature fit for such exactness ? and what class of men, or what individual, is capable of passing through life without one mistake ? However wearied, these men must be on the alert, and perform exactly every six seconds an act on which life depends. As to the first objection, we cannot expect a man-engine for every new mine, but every new mine does not require it. The beginning cannot be deep. The

* See 'Exploitation des Mines.' Par M. Ch. Combes, vol. iii. p. 176.

expense of sinking to great depths is so great, that the additional amount for an engine appears but slightly to increase the capital required, whilst it enlarges the income, according to the evidence.

As to the constant attention, it certainly is not less than is required on ladders, although perhaps a dreamy person may forget his way, and at any rate the man-engine of Warocqué removes much, perhaps all, this difficulty. The speed is less than that of the skip, although greater than the ladder.

Stemples.—Opinions generally are, we think, against them, and to us the practice of using them for a great depth seems inhuman. A man goes up with his arms and legs stretched violently out, and a black gulf yawns below; under him and in the gulf his son goes also, hanging partly by a rope by which his father supports him. Some advocates are found even for this.

Ladders occupy much of the time where the mine is deep. At 260 fathoms about an hour and a-half is occupied in going up, and about half as much in going down. The men are anxious to arrive at the top, and strain themselves to the utmost. The young run up for a few years only. Their time is paid for as labour in some cases, but not apparently in all.* A miner says, "They do not care much for forty or fifty fathoms unless the air is bad, but they feel the climbing of ten fathoms in bad air." "To come up 300 fathoms, it being very hot down, is a tolerably tidy day's work itself," says Captain Rutter. M. Dunstan says, "I have known men in West Cornwall who died on the ladders. They have come up to the top of the ladder, and then dropped down suddenly from disease of the heart brought on by climbing." Mr. Christopher Childs and others consider that climbing in bad air, not climbing *per se*, is hurtful.

From a comparison of the amount of work thus performed, with the results of climbing in the open air, as practised in other trades, it would appear that the actual climbing of the ladders, if performed with moderate speed, and not so long continued as to hurry the circulation and respiration injuriously, would be no further grievance than that of wasting time and imposing needless toil; with the important exception, indeed, of exposing the men to great danger of catching cold after being overheated by such great exertion. But either speed or long continuance at one time of such exertion will increase the exhaustion at a very rapid rate. Horses may be driven gently twenty miles a day without injury, but they will soon be worn down if driven too quickly half the distance. As every coachman knows, it is the pace that kills, it is not exertion but over-exertion that does the mischief. The captains of mines, who climb as much or more than the men, do not suffer, because they do not climb so much at one time, and because they have not other hard work to do as well. They seldom climb from a great depth at once, but break the toil, stopping to examine the different levels on their ascent, and they therefore suffer far less from overstraining of the lungs, and over-exercise of the heart, than miners, who climb the whole depth without cessation.

* See No. 2,840 and 19,529 questions.

The evidence of the miners themselves is sufficient to show that something connected with the climbing is injurious. Nearly vertical climbing in the purest air causes violent heart-beating. It is probably a question of intensity; for example, you may burn a ton of coals in keeping a piece of iron warm for a month, but if you burn the same amount in an hour, you may melt the metal entirely. So with the ladders: the peculiar position encourages violent exertion. To rise 300 fathoms on a sloping hill in an hour and a half is a tourist's pleasure, and yet the length is added to the height. The evil must be partly mental, a constant strain on the attention, such as the fatigue a man feels after passing great danger.

The evidence is overwhelming against long ladders, whatever the explanation.

Skip.—The mode of access that seems to be the rival to the man-engine is by the skip. This rises from the lowest depths in two to three minutes; at South Frances mine, four or five, to 150 fathoms. The skip is an iron box with guides, so that it does not swing like the bucket. There is more time saved by this than by any method, and less trouble is given. The position is very cramped, you cannot move an arm when two are present. Captain Trahair says, "There ought to be a sort of bonnet over the men's heads;" we felt seriously the want of this. Captain Boyns does not think skips safe except in perpendicular shafts, being apt to go off the line. They are used in shafts which may not be quite perpendicular in their whole course.

The skip, according to Mr. Richards, costs 1*l.* 10*s.* a fathom; the man-engine 3*l.* 10*s.* When a chain breaks over an uncovered skip, it falls down on the heads, and even if the catch holds, there is no safety.* The safety-catch seems successful, but not always so, still this is clearly in the power of man. Shall we trust to the care and memory which may fail once only during a life, or to the skill of the workman; to the mind or to the machinery? A safety-hoist in Manchester fell, because a pin had been forgotten, and was fatal to one or more persons; it was safe only when all was in order. A few years ago, Mr. Binyon insisted that the hoist in his sugar-works, now belonging to Messrs Fryer, Benson, and Forster, should have six ropes, each of which should alone suffice for safety, and indeed, if anything went wrong, it was a question difficult to answer, whether the hoist would go up or down, it was so well counterbalanced. So admirably has this plan answered, that the one rope, in at least six years, has never broken or required changing. The conditions may be different from those in the mines, but a useful idea may be perhaps obtained here.

Capt. Pascoe and Mr. Cady say that it costs 4¾*d.* to lift a ton of men or of stuff 150 fathoms. They use Bennett's patent catch, and a wire rope. The men can come up in two minutes; and without a skip, they would require half an hour's climbing. We may here remark that if 150 fathoms can be ascended in half an hour, whilst it requires one

* On writing this on the 19th November, 1864, we read that eight men have yesterday been killed in this way, the skip also fell.

hour and a half to ascend 260, as elsewhere said, it would show that after the first half-hour the progress is nearly three times slower. $260 - 150 = 110$, which ought to be ascended in twenty-two minutes, whereas it takes sixty. The old men, it is added, would sooner work half a day than climb that depth.

The chairman of the Commission, Lord Kinnaird, says,* "It has been suggested that there would be a difficulty in sending down a sufficient number of men by a single skip; but if you could send such a carriage containing nine or ten men, as in coal mines, would not that surmount the difficulty?" "Yes; but our shafts are not so large," says Capt. Pascoe; "and therefore we could not have a platform large enough." Lord Kinnaird says, "Could not the men stand one over the other, in tiers?" "Yes, it might be done very nicely, I think." A skip for stuff brings up at present about 15 cwt., which is equal to ten men.

At South Frances, forty men go up and down in one hour. Six go in the skip at a time; it takes half an hour for all. Some have to wait; but they would only gain their fatigue if they went before, as they would not arrive sooner. The skip is a most convenient mode of raising up wounded men, and the rapidity of assistance may often save their lives. There must, however, always be a ladder-way, in case of accident either to man-engine or skip

Chains.—We may inquire whether we should go down by a rope or by a chain. M. T. E. Forster, Newcastle, says, "I would never go down upon a chain." He always uses wire rope, and changes it as soon as the outer wires are worn. He has it examined two or three times a day, and throws it away three months before he considers it to be done. He thinks it better not to depend on safety-catches, as by such dependence men feel less the importance of attending to the machinery. He uses cages, and in seventeen years no accident has happened in going up and down. We can desire no more than this. There may be more difficulty in metal mines, *but the problem of entering mines safely seems to be solved*, and the question is, "By what means shall the method be brought into universal practice?"

Shall we leave so much to men? It is said, and truly, that after all the genius of our engineers has done its part, our lives are left at last to a pointsman. He certainly is the most wonderful of machines. The real truth lies on both sides. We must see that the machinery is right, and then trust to the men; but finally we shall find that we must trust to men to see that the machinery is right, and the men also right: in other words, the more intelligent and trustworthy the oversight is, the greater is the security, and we come again to the old subject of education.

Care in Miners.—We went to a mine (not in Cornwall), and although only a bucket could be had, we wished to go down. It was needful, we were told, to wait a little, as "the usual man is not here." "Where is he?" "In bed." "What is wrong?" "He fell down

* P. 32.

the pit." "Why did he fall?" "The rope broke when he was about 30 feet from the bottom." "Another man that helps will take you down, and use a new rope." An old hemp rope, much mended, had been used. We did not go: if the most skilful man around had made such a blunder, what would the second do? If we swing in a basket 400 feet above the earth, we shall see that the man who holds us has not only some education but some common sense!

On this point we must say a word. We imagine that in these days, information goes from place to place instantly, but it is quite curious to hear the Cornish people speaking with fear of cages, such as are used in the coal districts, and of the Northern people equally dreading skips and ladders! We require men who know both plans, to give their opinions. It certainly is most fully done *vivâ voce.* Bigotry is not confined to religions. It is hard to say what class of men have least; we are all very liberal when dealing with subjects to which we have not attended much, but very severe burners of heretics when our own notions are assailed. If we had power to decide on the plan to be adopted for entering all mines, we could not do so from the evidence, but should say, "If men can be lowered and raised for seventeen years without any one injury, is it much to require that every mine should have its work done equally well? Take your own plan, but give us this result."

Work in the Mine.—When a shaft is sunk vertically, the miner tunnels forward, keeping on the same level. He makes long galleries. Mines of copper, tin, and lead are often found in extremely hard rock. The hardness and the rate of progress vary exceedingly. The rock is bored by long tools resembling chisels, struck with hammers about 8lbs. in weight. One man holds the borer. and another strikes. This is laborious work, and the position is often very cramped. The borer must be frequently turned round, the rock is ground to dust, and as such is drawn out. The hole is filled with blasting-powder, then covered with some soft material and beaten down or tamped. If this were not done, the explosion would displace nothing, the entrance must resist as much as the rocky sides.

Some persons beat down the powder without any cover to it; many accidents occur in this way. Frequently, the powdered rock or dust from the bore hole is used; sand or dry clay also. Capt. Phillips recommends clay, and it is certainly softer than sand. All agree that large pieces of grit or spar are dangerous. When we strike gunpowder with a hammer on sandstone, an explosion follows readily. It requires no powerful blow. This is much easier when on stone than on an iron anvil. To use sand, and to beat this with iron, seems to invite explosion. A fine soft clay will not, as far as we know, cause the same, and the fine powdered killas, as soft as flour, spoken of by Mr. Puckie, may be as safe. Hemp, tow, or cotton are also used.

It may be asked, is it needful to strike the first layer of tamping at all; is it not enough if the upper part be firmer, whilst the powder itself may only be slightly pressed by the soft tamping material. We

could then increase the power of the blows till the last layer was added.*

At present, violence is often used from beginning to end; and there are different opinions as to the proper use of it. All agree that the hole ought to be wiped out with a swabstick or wet rubber to remove all grit. Some put the powder in a case or cartridge, and others a mere covering of brown paper. Capt. John Webb took a patent for a case with a wadding of cow hair as a foundation for the tamping. This soft material seems a move in the right direction.

In many places, it is directed that the first blows shall be given with wood, and sticks are provided for the purpose, but the men pay no attention. In other places, copper rods have been tried. The commissioners recommend the use of bronze tamping rods. Lord Kinnaird has had one used for a year, and has found that it wears well, and is safe. It may be supposed, however, that we must not even use these on the bare powder or with much grit.

If the tamping filled up the hole entirely, the powder could not be ignited; there is, therefore, a fuse inserted, made of a slowly burning mixture. This must be in a tube strong enough to bear against the pressure of tamping. If the tamping material is hard, it may break the tube, which is made sometimes of canvas and tar.

Before beating the tamp, it is needful to clean the mouth of the hole with a wet substance, a swab-stick to remove all loose particles of gunpowder: neglect of this is often fatal.

To tamp properly, one man is sufficient: he holds the rod with one hand and strikes it with a hammer in the other. In doing this he feels his way, and if any hard substance intervenes he can take precautions. When one man holds and another strikes, as in boring, such violent blows are given that there is great danger, from a want of sympathetic action between the hammer and rod. This habit is forbidden. In some places this or the neglect of wooden rods is punished by the refusal of relief from the club in case of accidents.

Now the fuze is lighted and the men rush off into corners. They wait anxiously for two minutes; sometimes there is no explosion and their labour is lost. If they have prepared three holes and only two go off, they are much chagrined. The rule in some, if not all mines, is that no man shall go near a hole in this uncertain state until next shift. This rule is valuable; strange chances prevent the timely explosions, and many a man has been blown back who rushed too hastily forwards to seek an explanation of a delay which, after all, he had merely imagined as he was standing alone in his dark corner.

We remember seeing an instance of this haste. We were exploding some gun-cotton, a dozen men were near, and when above the usual time was past, several rushed forwards. The cautious men were not among the workmen; some called out, "Wait longer," ann well it was, because after waiting nearly double the usual time, the explosion occurred. Why was this? Some interruption in the fuze; some of the mixture, perhaps, a little moist, or containing less powder, so that it burned more slowly than usual.

* See Captain Boyn's evidence.

We have described two operations, entering the mine and working in the rock, at some length, but when they are well considered, they will render the remaining portion more intelligible. When the explosion is made, the miner rushes to it with his candle, he is anxious to know what treasures have been sent to him from the hitherto invisible world, and if he has taken the work for himself he is doubly anxious. Yet why should he go? he must not remain, as the smoke blinds and chokes him, helping also to extinguish his light; he is obliged to return and sit down half an hour till the smoke clears away. This is idle time, and in a mine there is a good deal of time that may be spent without violent work. To avoid this difficulty of measuring labour, the plan of tribute work is sometimes adopted. The men make offers for a certain piece of ground and take their chance with it.

We must not lose sight of the blast. When the rock splits it may strike persons not carefully stationed, and when some portions are displaced, others may fall and do grievous injury. These are accidents of no uncommon kind. Even when the loose rocks are of no value, they may be taken up to the surface so as to get rid of them, but they may also be used to fill up spaces that have been worked out, in which case, they are built up like walls. These walls vary as much in construction as do the Pyramids and an Irish cabin. Some cannot bear touching; other places have great masses supported by wooden beams, and this wood decays. There are walls also built with the greatest firmness, neatness, and security; this is remarkably so in German mines. The long galleries are called levels, but more properly speaking a level is a story, with passages in it. A shaft may lead to a story lower, and there may be shafts communicating at various points, with these levels or stories. These shafts are called winzes. When you are moving along the passages, careful that you should not strike your head against the roof, you are told to mind your light; as the water is dropping, you feel the rain and become attentive to the candle. Then you are told to mind your feet, as it is very wet, but you become reckless and step into any depth of mud. Then you are told to be attentive as there is a deep hole, a shaft or winze near, and only a plank across it, not a very safe one; or perhaps it is the mouth of a sump or perpendicular cut. You immediately attend to the plank, but no, you must not forget your head. Persons rush forward looking to their feet, and dash their heads unhappily. We must watch the rocks above and below, with our elbows feeling the wet sides, and our hands on the candle, ready, however, to grasp the plank should we trip. There must be no inattention when walking through a mine. You pass this hole and move on, you find that the current of air made at the opening ceases entirely; you see no way forward until you are told that the heap of stuff lying in the way does not reach quite to the roof, and you have room to crawl over it and reach the other side. Up to this time you may have fancied that you were keeping yourself moderately free from the mud around you, although your hands were covered with clay, and the candle-grease had mixed with it, but here you relinquish all such ideas, and abandon yourself to your fate. No miner comes out so brown as you,

and none so badly taken care of, although you imagine that you have been all your life accustomed to cleanly habits.

All these conditions produce dangers sometimes fatal. The dangers to which workers in mines are subject, are as follows: *—

Falling down the shaft, &c.: Uncovered winzes, sumps, and holes; rotten or broken ladders; fatigue; falling from the steps of man-engine; from the skip or carriage slipping off the guide; the breaking of chains and ropes; falling through winzes not covered.

Beams, &c.: From the falling of walls and heaps, stone or kibble; from the lifting part of the shaft not being divided from the road-way; from the rotting of wood, or decaying of props.

Explosions: Caused by careless tamping; hasty return after lighting; fall of rocks.

Air: From powder, smoke, and dust of the exploded rocks; from candle smoke and bad ventilation generally; from stagnant air not lately entered.

Water and temperature: Neglect of health and life laws; constant exposure to moisture, to hot air, and to cool currents.

Heat of the mines, &c.: Long distances to walk home; sudden changes at the surface in wet clothes; sudden irruptions of water, from the old pits not well covered at the surface; working out of doors at surface work in all weathers.

From being made to work in the mine too early in life.

From bursting of boilers.

Inquests are held after violent deaths, it is true, but the coroners and the jury seem alike to be imbued with the spirit of the place, and the frequent verdict of accidental death, although so far correct, neglects to say that such accidents are avoidable. We require to move nearer to the cause, and in most cases to make an accident itself into an offence. Accidents do not occur where there are sufficient precautions. Nearly all accidents are faults, amounting to crimes, arising from ignorance or carelessness, whether in mines or out of them.

We have thus referred cursorily to various points of interest connected with the mechanical means employed in metal mining, and to the immediate risks attendant thereon, as revealed by the recent Report of the Mining Commissioners. To consider, in addition, the equally important question of the health of miners, would occupy more space than can be devoted to a single article in this Journal, and we must, therefore, reserve our review of that portion of the subject for another occasion.

* See 'Report of Commissioners and Appendix.'

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

During the past autumn, after several months of the long-continued drought of 1864, Professor Church, of the Royal Agricultural College, examined for water the thirteenth inch in thickness downwards from the surface of a clay-land field near Cirencester. Several samples of the subsoil taken from this depth were analyzed. In one case, where the soil had been deeply cultivated during the previous autumn, no less than 28·6 per cent. of the apparently dry layer examined, was water. In another, where the subsoil was taken from uncultivated land, which had not been disturbed within memory, the percentage of water was 19·2. In a third case, the subsoil of a kitchen-garden which had been deeply trenched in autumn, yielded 26·2 per cent. of water. In a fourth, the subsoil in the same garden, where the bed had been only half dug, yielded 20·5 per cent.

There had been no rain to speak of since the spring, and yet these enormous quantities of water still remained in the subsoil. The soil experimented on is "a light calcareous clay loam, resting on the Forest marble." These facts are instructive, both as showing the great storeage of moisture within the land, available during seasons of drought, and also as indicating to tillage farmers the greatly-increased capacity for moisture which deep and thorough tillage gives to land.

We mentioned last year the publication of Lectures on Dairy Farming, by Mr. Harrison, M. Inst. C.E., of Frocester Court, Gloucestershire. This gentleman having for several years kept a record of his dairy experience has reproduced it all by means of curved lines, representing the varying weekly milk produce of individual cows, and of the whole herd throughout the year. The annexed diagrams are prepared from his figures. They indicate the weekly yield per cow of the whole herd during the three years named. It is plain that if the weekly quantity of milk yielded by a cow were represented by vertical lines of correspondent lengths, stationed at equal intervals along a base line of sufficient length to receive fifty-two such lines for the successive weeks of the year, they would, in any ordinary case, where the cow had been kept in health and produce by a uniform method of feeding, commence at a maximum height, and gradually dwindle. The curved line joining their extremities, whose distance from the base line at the summits of the vertical lines thus joined would show the varying yield of milk from week to week throughout the year, would commence at once, perhaps some time in March, at a maximum height, representing possibly a produce of twenty, or two dozen gallons weekly: it would maintain a nearly level course till after Midsummer, and, gradually dwindling through the autumn, it would touch the base line, indicating an entire cessation of produce towards the end of the

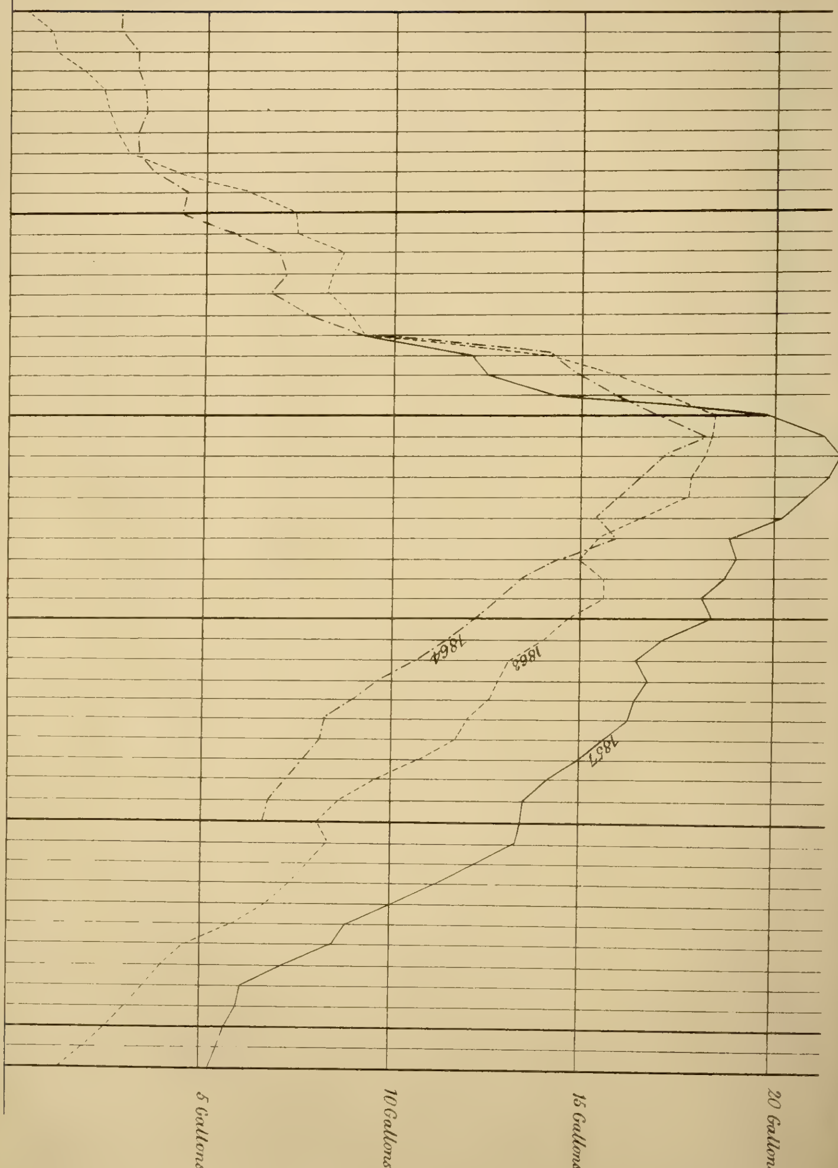

DIAGRAM SHOWING WEEKLY YIELD (DURING 3 YEARS) OF MILK PER COW.

year. There are, however, many things upon a farm which interfere with the uniformity of the curve of individual weekly milk produce. For instance, cows are not fed uniformly throughout the year. They generally begin with hay and roots, immediately after calving, not getting on to grass till May, and this grass gets short during haymaking time, increasing in abundance when the aftermath is available. Neither are cows in uniform health, nor is the weather by any means a uniform influence. All these things interfere with the uniformity of the yield of milk and with the regularity of the curve representing it. The curve given on the annexed diagram represents, not the yield of an individual cow; but the yield per cow of the whole herd; and here another item comes in to affect its character. Cows do not all come to the pail together, and thus the milk produce of a dairy-farm never altogether ceases. The curved line representing it, thus never altogether touches the base line. It rises rapidly during the spring months as the cows are calving, and as the green and succulent food of the pastures becomes available: it rises to a height dependent on the dairy character of the herd, and the abundance of the food supply; it falls occasionally, with more or less regularity, according to variations of temperature and of food and health. All these particulars are observable in the curves before us. The curve of 1864 is not so high as usual, owing to the deficiency of food in the fields, which the drought occasioned. The curve of 1863 shows a remarkable depression during autumn, owing to an attack of the distemper from which the whole herd suffered for several weeks. Occasional depressions seen in others of the curves, which are owing to bad weather, will probably be found paralleled in the annual temperature curve of the time, if it be examined. And every one of them exhibits more or less of a depression during June or July, when the food supply suffers just before the aftermath comes into use. We give these diagrams to illustrate both the quantity of information which may be thus conveyed to the farmer, and the intelligence which is now brought to bear upon the varying experience of the farm.

The utilization of London sewage is again occupying attention. Baron Liebig has written to Lord Robert Montague, who had obtained a Committee of the House of Commons for the consideration of the subject, to declare that it is not a complete manure, but must be supplemented with additions of phosphate of lime and other ingredients, according to scientific recipes, or it will soon create as much agricultural disappointment as it is now exciting hope. Sewage is deficient in phosphoric acid, and therefore, says Baron Liebig, although " on a soil rich (in its natural state) in phosporic acid, it will have an excellent effect, producing, for instance, large crops of grass, turnips, and corn, if the soil supplies the quantity of phosphoric acid wanting in sewage, yet as in each successive crop, a certain quantity of phosphoric acid is abstracted, the total quantity is by the continual application of sewage gradually diminishing every year, and a time must come when the phosphoric acid is insufficient for further crops, and when sewage ceases to produce its former effects." Accordingly, " for each crop the composition of the sewage ought to be corrected according to the

nature of the soil, by adding those ingredients which are wanting in sewage, and which the plants to be grown require in the largest proportion."

We are not at all likely to see the time even in our little country, where agriculture is progressing from year to year, when crops shall be cultivated with success by the aid of scientific recipes. Whether sewage be a lop-sided manure or not—and we suppose it is incomplete, to the extent, at any rate, of a definite quantity of bones, it is certain that its weakest side possesses, in the quantity which should be applied to land, superabundant strength.

The Craigentinny meadows, below Edinburgh, which have been irrigated with sewage water for a century or more, have continued to yield 30 to 40 tons per acre, a produce for which Edinburgh cow-keepers are content to pay 20*l.* to 30*l.* per annum. And on the lower part of them, more recently reclaimed from the sea-shore, where the original fertility of the land was absolutely nothing, the produce of grass is as abundant as anywhere else. It is plain that Liebig's letter has been written in the interests of that particular scheme for using London sewage, which proposes to take it over many hundred thousand acres, and distribute it at the rate of 2*d.* per ton, or thereabouts, to the farmers, who will, no doubt, want something, whether compounded by the chemist or not, to supplement the two or three hundred tons per acre, with which it is believed the land will thus be fertilized. The other scheme, which proposes to irrigate a comparatively small area, has all the agricultural analogies in its favour. Craigentinny, Croydon, Rugby, and Carlisle can all be quoted in its favour. Meanwhile, there are 100,000,000 tons per annum now running out to sea at Barking, and it is a shame to the agriculturists and commercial men of England that such a mass of fertilizing matter should thus run to waste.

The proposal for turning it to use, which the Metropolitan Board of Works has sanctioned, and which will come before Parliament this spring, includes the lifting of the whole some 40 or 50 feet by pump, and thereafter letting it flow along a channel down to the south-eastern shore of Essex, where there is a great tract of foreshore left dry at low water, ready to be embanked, and fertilized. The *Oxford Journal* thus describes the plan :—

"There are several special advantages connected with this scheme for the utilization of London sewage which must not be forgotten. The district where it would thus come into use is not a residential district. The country which would thus be fertilized is very thinly populated. And any nuisance which might be created would thus affect but very few. Again, at the end of the forty miles of line, there is a tract of foreshore—the Maplin Sands and the Dengie Flats—where 20,000 acres or more might easily be embanked from the sea. So that here we have at once an estate to be fertilized, where every 10,000 tons of sewage may be converted into 30 or 40 tons of grass, and this into about 5 or 6 cwt. of meat, or a corresponding value of milk, which will be sufficiently profitable both to tempt and pay expenditure. There would thus be an outlet at once for this 100,000,000 tons of sewage ; and this poor land, which would need at first enormous supplies of fertilizing matter, might thus for a

few years receive nearly the whole of this enormous quantity. In the mean time all the low-lying land along the course of the new sewage river would gradually be receiving a portion here and there, as its tenants realized the advantage of the dressing, and ultimately, in all probability, only a portion of the material would reach the terminus estate, which would, however, by that time be in a condition to do with less. And at length, no doubt, if the supply should exceed the demand for both these purposes—reservoirs might be obtained here and there along the line, into which pumps will deliver portions of the manure, so as to command the higher land, for which a portion of the sewage may be wanted.

"It seems to us that the South Essex scheme—using the sewage in the district towards which Mr. Bazalgette's channel already takes it—using it in a district where the nuisance it will create must be a minimum —taking it along a line where cheap land is to be had, to a terminus where an absolute waste exists, which may be enclosed and fertilized—is most in accordance with the existing experience in the use of sewage. In its terminal enclosure, and the long line of suitable country which may ultimately be benefited—it combines all the elements of ultimate success."

The drought of the past season has resulted in an unusual failure of the turnip crop ; and considerable difficulty is thus experienced in providing food for the live stock of the farm through winter.

The prices of meat and wool are, however, such, that the large expenditure in grain and meal, and the refuse cakes of the oil-mill for feeding purposes, will prove profitable ; and it is hardly to be doubted that the large experience in richer feeding which is thus forced upon the farmer, will gradually lead to a larger meat manufacture generally upon farms in seasons of greater productiveness, and thus, through the larger dung-heap of the farm, to increased fertility.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

The science of Astronomy is ceasing to be so exclusive, and now draws important aid from other branches of natural science. Putting out of the question the assistance which the optician and his science have always given, and which has been abundantly repaid in the important knowledge concerning the laws of the propagation of light, which has been reflected back by astronomy, we may instance the wonderful contributions to our knowledge of the composition of the heavenly bodies which has been yielded by the spectroscope ; the share which chemistry has in the spectrum discoveries, and also in the composition of meteorites, and the deductions derived therefrom ; the application of photography to the delineation of the conformations of lunar, solar, and planetary surfaces, and the positions of fixed stars ; and, lastly, the great service which electricity is doing for the practical astronomer in recording transit observations. In nearly all these branches we have something of value to communicate, although in pure astronomy but little progress has been recorded since our last issue.

By far the most gigantic work that has appeared for many years has just been published, as the first part of the 154th volume of the 'Philosophical Transactions of the Royal Society;' this is the catalogue of Nebulæ and Clusters of Stars by Sir John W. Herschel, being a catalogue of no less than 5,079 objects, arranged in tabular form, giving, besides ample references, the Right Ascension for 1860, January 0, the annual precession in Right Ascension for 1880; the North Polar Distance for 1860, January 0; the annual precession in North Polar Distance for 1880, and a summary description from a comparison of all the observations, remarks, &c. The present catalogue is published at a most opportune time, as, should the efforts which are now making to procure for the University of Melbourne, in Australia, a reflector of the first magnitude prove, as is to be hoped, successful, it is understood that one of the principal uses to which it will be devoted will be the examination and exact delineation of the numerous and wonderful objects of this class which the southern hemisphere presents. The present work is a general catalogue of all the Nebulæ and Clusters of Stars actually known, both northern and southern, so arranged and reduced as to enable an observer at once to turn his instrument on any one of them, as well as to put it in his power immediately to ascertain whether any object of this nature which he may encounter in his observations is new, or should be set down as one previously observed. For want of such a general catalogue, in fact, a great many nebulæ have been, from time to time, in the 'Astronomische Nachrichten,' and elsewhere, introduced to the world as new discoveries, which have since been identified with nebulæ already described and well known. Many a supposed comet, too, would have been recognized at once as a nebula, had such a general catalogue been at hand, and much valuable time been thus saved to their observers in looking out for them again.

Mr. Lassell has offered to the University of Melbourne his four-feet equatorial, constructed by himself, at present in use at Malta. This magnificent gift has been accepted by that body, and it will, we expect, before long be on its way to Australia.

Mr. De la Rue has given an interesting account of his recent visit to Russia, in order to be present at the twenty-fifth anniversary of the Pulkowa Observatory, which is now under the direction of M. Otto Struve, son of the late director, M. W. Struve, of world-wide renown. Within the last few years great pains have been taken to test the accuracy of the instruments, it being desired that the observations made with them should give the *absolute* places of celestial bodies. The electro-magnetic recording of transit-observations has been adopted on a plan differing somewhat from that employed at Greenwich. In the first place, the tappet-apparatus is held in the hand, not attached to the transit, as at Greenwich; and when the observer sees a star enter the field, *he records on the registration-paper, as it is unreeled, the name of the star, expressed in Morse's alphabetical signals*; together with any remark he may think necessary; then, as the star crosses the wires in succession, the tappet-apparatus, moved by the hand, records each contact; and, when the star has left the last wire, any further remark

can be registered on the paper. During the time that the paper has been unreeling by means of a clock-work driving apparatus, the normal clock has recorded the seconds, and indicated the commencement of each minute on a scale of seconds placed parallel with, and in close juxtaposition to, the indications transmitted from the transit. The traces are made with diamond points on mat-black paper, which becomes burnished under their pressure, and shows two bright lines, which, the points being always on the paper, would be continuous, but for the interruptions of the current, produced, on the one hand, by the beats of the clock, and, on the other, by the operator's signals from the transit. These interruptions cause a sort of battlement, like that on a crenulated wall, to project from the lines, the commencement being the exact second, or the precise moment of transit, as the case may be. The reading off is perfectly easy, and is capable of great exactness, either by estimation or by actual measurement. The batteries used are Meidinger's modification of Daniell's, and give great satisfaction, the elements being copper in contact with a solution of sulphate of copper, and zinc in contact with sulphate of zinc, or sulphate of magnesium; and the two fluids, neither of which is placed in a porous cell, are kept in surface-contact.

A very great improvement has been adopted in the arrangement of the normal clock belonging to this observatory. Clocks vary owing to three causes. The first being unavoidable errors of workmanship; the second, the variation of temperature causing the pendulum to lengthen and contract; and the third the alteration in the atmospheric density, the pendulum meeting with less resistance while passing through the air when the barometer is low than when it is high. Horology has now been brought to such perfection, that it is believed that if the second and third causes of error could be compensated for, the first would be almost imperceptible. The temperature error is generally corrected by the mercurial cistern, but the far greater bulk of the latter and its contents in relation to surface as compared with that of the pendulum rod renders it impossible for the mercury to take up any change of temperature so rapidly as the rod; hence the rod varies in length far before the mercury can, by expanding or contracting, prevent an inevitable shifting of the centre of oscillation in reference to the axis of suspension. This serious defect in the mercurial pendulum has been guarded against at Pulkowa, by removing the clock which was formerly embedded in one of the piers of the central hall under the great equatorial, and placing it in a subterranean chamber beneath the hall, in a situation where changes of temperature occur very slowly, and where the limits of change are very narrow from one period of the year to another. The barometric error it is also intended to remove by placing the clock in an air-tight case, in which a constant pressure will be maintained by means of a pump to be brought into use whenever it shall appear from the indications of a pressure gauge to be connected with the clock case, that there is a variation in the density of the air around the pendulum.

Mr. De la Rue also describes a very ingenious method of communicating time signals for controlling other clocks by the normal clock

of Pulkowa. On the frame of the clock, one on each side of an imaginary plane, which would cut the centre of the crutch, are fixed two ivory cylinders, each of which having cemented in it a capillary tube of glass; these two capillary tubes are open and point to one another, and are connected with two reservoirs of mercury, so that a stream of that metal issues from each capillary tube, and these two streams uniting, form, as it were, a wire of mercury connecting the two reservoirs; and these reservoirs being connected with the respective poles of a battery the circuit is completed, and the current continually transmitted so long as the mercury-wire remains unbroken. The breaking of the circuit at the desired intervals is thus effected. To a prolongation of the ordinary crutch is attached a thin blade of mica, capable of adjustment as to position; and this blade of mica as the pendulum and crutch oscillate, cuts through the mercury-wire, thus breaking the circuit and causing the signal to be transmitted. The position of the mercury-wire and that of the mica-blade being capable of adjustment with reference to each other, break of contact can be made to coincide absolutely with the beat of the clock, and the duration of the break can be regulated by varying the width of the blade of mica.

With further reference to the subject of the transmission of correct time, Mr. De la Rue states that the Liverpool Observatory is about to be removed to the Birkenhead, or opposite side of the Mersey, so as to make room for dock improvement; but, in order that its great utility to the mercantile navy may not be interfered with, it is intended to place a chronometer room in a position easly accessible to mariners, and to transmit time signals to and control the clock of that establishment by means of electric communication with the normal clock of the observatory. Jones's system of controlling clocks has been for some time past successfully practised in Liverpool, where the value of accurate time is fully appreciated; and we all know that in Scotland the transmitting of time signals, either by gun-firing or by controlled clocks, has created a great sensation. London, however, is still deficient in this respect; and notwithstanding the admitted truth of the adage, "Time is money," and the proximity of Greenwich, accurate time is not obtainable at any public establishment, whereas one would imagine that in the City, at least, controlled clocks would be placed in the various centres of commercial activity. Mr. De la Rue relates that he can speak from his own personal experience as to the practicability of transmitting time signals, and controlling clocks by electric agency, for in his own works, Mr. Walker, in conjunction with Mr. Jones, has, by the kind permission of the Astronomer-Royal, placed a clock so perfectly under the control of the Greenwich clock, that unless there is some derangement of the wires, it beats for months consecutively, second for second, with the clock at Greenwich; and in case of an occasional variation, a signal comes four seconds after every hour, and furnishes a means of correction.

With a view to the determination of the parallax of the fixed stars, Dr. Winnecke, the vice-director of the Pulkowa Observatory, is having erected in a small observatory at a little distance from the main building,

an equatorial which can be clamped in any desired position in or out of the meridian, so as to remain immovable during the required interval. It is intended to observe the transit of groups of stars near together at different periods of the year, and to record the observations by the chronographic method. We thus perceive that the automatic method of registering astronomical phenomena, is step by step extending. There is a degree of proficiency beyond which no amount of training can carry human skill; and when this has been reached, it is a fit and proper development to call in the resources of the human intellect to devise mechanical contrivances which shall accomplish any desired end with a precision not attainable by human organs, however highly trained.

Whilst we are speaking on the subject of clocks we may mention that at a late meeting of the Literary and Philosophical Society of Manchester, Mr. Baxendell described a remarkable derangement of his sidereal clock caused by the earthquake which occurred on the 26th of September. At the same time he suggested a new method of registering the occurrence of earthquake shocks based upon this circumstance.

A new planet, making the eighty-first of the group existing between Mars and Jupiter, has just been discovered by M. Temple of Marseilles. Its brilliancy is that of a star between the eleventh and twelfth magnitude. The discovery has been confirmed by the observations of M. Luther, of Bilk.

An interesting illustration of the dependence of one science upon another has just been shown by the chemical analysis of the remarkable meteorite which fell at Orgueil. MM. Descloizeaux, Daubrée and Cloez announce the discovery in it of a crystallized carbonate of magnesia and iron; the meteorite containing a little more than one-half per cent. of carbonic acid. These are small facts but valuable, since the presence of this crystallized carbonate proves that the meteorite could never have been exposed to a very high temperature.

Proceedings of the Royal Astronomical Society.

Astronomers for many years past have suspected that there were changes going forward on the lunar surface. Indeed, five years ago, the Rev. T. W. Webb submitted to the Society a notice of traces of eruptive action in the moon, in which he drew attention to the spots Cichus and Messier, as furnishing probable evidence of the continuance of explosive force during the present century. The reverend gentleman has now made another contribution to this interesting subject, but owing to the imperfections in the great map of Beer and Mädler, the cases of suspected alteration now pointed out are by no means conclusive that changes have taken place. It seems generally admitted that no alteration of any considerable magnitude has taken place upon the lunar surface since the date of anything which can be called accurate observation; it is only in the smallest class of craters therefore that we can reasonably look for traces of continued activity; and

it is precisely *there* that we become sensible of a deficiency in the work of the illustrious German astronomers; in some instances we find these minute details laid down with less regard to accuracy of position than would have been desirable; in others we are inclined to question whether they actually represented all that their instrument was capable of showing them, and that they therefore might have seen, especially if they had been willing to avail themselves of the labours of their predecessors. A remarkable instance of this is to be found in the great plain recently termed by Dr. Lee the *Mare Smythii*, where Schröter's figure, under the name of Abraham Gotthelf Kästner, is much more faithful than their own; and another in the *Sinus Aestuum*, where their assertion that no craters are discernible, was afterwards retracted by Mädler, and never, one would suppose, could have been made had they consulted the design of Lohrmann. It is the unfortunate want of confidence in our highest standards thus necessarily resulting, which throws some doubt upon the evidence of change which Mr. Webb adduces, and renders an appeal to the future still necessary to render it conclusive.

Eight separate instances of suspected change are now recorded by Mr. Webb, some of these are certainly too doubtful to require more than a passing notice, but others deserve careful scrutiny from time to time and very accurate comparison with well-executed drawings, or if obtainable, photographs. We will give a short notice of the most noteworthy of these instances.

On February 8, 1862, the S. and S.W. slope of the magnificent ring, *Copernicus*, was seen to be thickly studded with very minute craters not represented by Beer and Mädler. The omission is chiefly remarkable as they form a continuation of the extraordinary assemblage of similar foci of eruption lying between *Copernicus* and *Eratosthenes*. This latter wonderful district, it may be observed, by the way has probably assumed its present honey-combed aspect during the present century, as it is hardly conceivable that in such a situation it should have escaped the persevering scrutiny of Schröter, and been left for the eye of Gruithuisen in 1815.

Another instance of probable change is afforded by the ring mountain *Mersenius*. This is remarkable for the very unusual feature of a convex interior, which was discovered and well drawn by Schröter, and appears then to have had no object upon its summit. It is represented equally smooth in the map of Beer and Mädler; and from their description, we are assured that this was no error in the drawing, for they speak of several inconsiderable ridges and terraces round the inner foot of the ring, and a general upheaving of the interior towards the centre, so that for some hours this bubble-like convexity casts a dictinct shadow to the eastward in the increasing moon, and they have, though opportunities are not so frequent, seen it falling in the opposite direction; but they expressly add, that "a central mountain is totally absent." No further evidence can be needed to show that they had thoroughly investigated the spot. Now in the year 1836, the Rev. T. W. Webb perceived, on the summit of this well-known convexity, a minute crater, and several other delicate

markings. The aspect of a considerable portion of them is that of a line of long irregular ravines, without elevated margins, as though they had been formed by the dropping in of part of an inflated and hollow crust. We have here something that certainly looks like evidence; and it would seem as though the epoch of the supposed convulsion might be fixed within narrow limits; for the map was published between 1834 and 1836, while Mr. Webb's first detection of these objects took place in 1836. The value of this evidence in favour of recent change on the lunar surface is, however, somewhat diminished when we find that Lohrman has inserted a minute crater on the convexity in his map, made from observations taken between 1822 and 1836.

W. Lassell, Esq., has figured and described an unusually irregular outline of the moon's limb, as seen with his 9·1 inch reflecting equatorial, at Malta, where it is at present mounted. A mere description will hardly convey an idea of the irregularity; but the drawing given in the monthly notices of the Royal Astronomical Society, shows sharp peaks of mountains and deep valleys interfering with the regular outline of the moon, whilst one portion, extending over more than 11 degrees of latitude, is quite flat, if not really concave. Mr. Lassell, in conjunction with his talented assistant, Mr. Marth, has also sent to the Society several measures of the small star, in the neighbourhood of *Procyon*, both in position and distance. They scarcely tend to establish the hypothesis of any physical connection with the large star. They have also sent the results of a series of observations of *Uranus* and *Neptune*, made during the splendid, and, as it now appears, exceptional season of 1852. They are at present much occupied with *Saturn*, in observing, amongst other phenomena, conjunctions of the satellites (especially the closer ones) with the pole of *Saturn*, or with tangents to the limbs or ansæ of the ring, with a view to contribute towards a more perfect knowledge of the forms of their orbits. Mr. Lassell has likewise made a good many drawings of planetary and other nebulæ; but has not yet decided about publishing them. An engraving from a drawing of the large nebula, *Messier* 20, will be given in the volume of 'Memoirs of the Royal Astronomical Society.' It is the work of an Italian artist, and is in the main very correct, though the shading-off of the nebula is somewhat too abrupt, and the proportional magnitudes of the stars are not perfectly preserved.

A contribution to our knowledge of the astronomy of the ancient Egyptians has been sent to the Society by Mr. Bonomi. He has given a drawing from a diagram, engraved on the wall of the Belzoni Sarcophagus, which was made to contain the body of a king of Egypt 1,250 years before our era. In the upper part of the diagram is a figure of Osiris, curled up in the attitude of a tumbler, to represent the earth floating on the surface of the great ocean, which is here signified by zigzag lines that surround him. This idea of the earth floating on a vast expanse of water was entertained by all the nations of antiquity, and there is frequent allusion to this idea in the sacred writings. A little figure, standing on the head of Osiris, is the god-

dess of heaven, Neptè, supporting the sun, which is connected by the Scarabæus with certain divinities in a boat, held in the outstretched arms of a figure, supposed to represent the ocean. That part of the picture relates to some Egyptian dogma respecting the soul, which has not yet received a satisfactory explanation.

In a letter from Mr. A. Herschel, detailing some account of the observations of Professor Hees, of Münster, 'On the Radiant Points of Shooting Stars,' we find the following important points established. 1. The interval of a quarter of a century may produce *no sensible alteration in the direction of a meteoric stream;* and 2. Two meteoric streams may arrive at the earth at an interval of not more than ten days apart, *almost exactly transverse to one another in direction.* These facts are exceedingly difficult to explain upon general grounds; they are both, however, perfectly conformable to the hypothesis that shooting stars are cosmical bodies revolving round the sun.

Lieutenant-Colonel Strange has described a zenith sector, for the use of the Great Trigonometrical Survey of India. Owing to the grave imperfections of the old form of zenith sector, the Astronomer-Royal designed, and had executed, a new instrument for the Ordnance Survey. This instrument is one of the most original ever devised, and the work executed with it is of a very high order, but owing to its massive construction and great weight, being altogether 1,140 lbs., it is evidently unsuited for crossing the higher Himalayan ranges. The weight of Airy's Zenith Sector is chiefly due to the manner in which the azimuthal motion is obtained, namely, round two points external to the telescope and sector. The abandonment of this primary feature involved the abandonment of the whole design; and the subject had to be taken up *de novo.* Mr. Airy's fundamental principles being, however, preserved as a basis. A brief account of the new instrument is given by Lieutenant-Colonel Strange, in the monthly notices of the Astronomical Society, No. 9, to which we must refer those of our readers who wish to pursue the inquiry further. The work is being executed by Messrs. Troughton and Sims, and it is expected that it will not weigh more than 600 lbs.

A notice of Dr. Steinheil's stellar spectroscope has been given by W. G. Lettsom, Esq. With this instrument the colours of the stellar spectra are as distinctly pronounced as when one examines the light of the sun by means of a prism. The spectra of the larger stars are displayed with such brightness when the spectroscope is used with a nine-inch refractor, that there is hardly any doubt that it would give very satisfactory results with stars up to the second magnitude, when applied to instruments of not more than four inches aperture.

An elaborate paper has been communicated to the Society by Lieutenant-Colonel J. T. Walker, R.E., on the method of determining heights in the trigonometrical survey of India. The difficulties which beset observations of vertical angles in the plains of India are so great, and the inaccuracies to which they are liable, so serious that the observations taken before the year 1856 by the method of reciprocal vertical angles were a cause of much anxiety and uncertainty, because if erroneous, the lengths of the base lines and all operations emanating therefrom

would be erroneous. It was consequently determined to undertake a series of spirit levellings to fix the heights of the base lines, and verify a certain number of principal stations, more particularly those situated in the plains previously referred to. The main lines of levels were executed by at least two persons, each furnished with a standard level and pair of staves, one following the other, station by station, at a few minutes' interval. The various sources of error, and the precautions taken in order, as far as possible, to remove them, are detailed and discussed. It is stated that a comparison between the results of the spirit-levelling operations and those obtained from the principal triangulation, is found to be highly satisfactory in all instances where the vertical angles were measured at the time of minimum refraction, even where the triangulations had been carried for long distances over the plains already noticed. The average difference obtained at the end of four circuits, averaging 550 miles in length is 3·06 feet, and the maximum difference at any station is 8·7 feet, which occurs at a station in the valley of the Indus, 200 miles from the nearest hill station. In combining the trigonometrical with the levelled values, the latter are assumed to be correct and final; and stations obtained by the former process alone are referred to the nearest station of the line of levels.

Sir John Herschel has proposed to the President of the Society that an eyepiece for viewing the sun should be constructed, in which the eye would be defended by a revolving metal plate, having in it two very narrow slits diametrically opposite, each occupying a sector of the disc, say half a degree. The diaphragm being made to revolve five times in a second, a glimpse would be caught at intervals of one-tenth of a second which suffices for continuous vision. But the quantity of light which would enter the eye would be only 1-360th part of the total light of the sun. If the disc were an annulus of ten inches diameter, and the slits, four in number, were each 1-100th of an inch in breadth, the annulus revolving once in 2-5ths of a second, the quantity of light would be reduced to 1-785th part; and if the surface of the annulus next the sun were of polished metal or looking glass, the annulus itself would not become very hot. The annulus and the apparatus setting it in motion might be disconnected with the telescope, so as not to communicate tremors.

III. BOTANY; INCLUDING VEGETABLE PHYSIOLOGY AND MICROSCOPIC BOTANY.

Tetrapanax papyriferum, the rice paper plant, appears to suit the climate of New South Wales. M. Swinhoe gives an account of it in the 'Pharmaceutical Journal,' and describes the process of the preparation of the paper as follows:—

The cellular tissue or pith attains its full size the first year. The trunks and branches are mostly procured from the aborigines of the inner mountains, in barter for Chinese produce; they are rarely

straight throughout their length, and are usually cut into pieces of about nine inches long, and with a straight stick inserted at one end and hammered on the ground, the pith is forced out with a jerk at the other end. The pith is then inserted into straight, hollow bamboos, where it swells, and dries straight. If too short to form the required breadth of paper, several bits are inserted into a hollow bamboo, and, by rods inserted at both open ends of the bamboo, pressed together until dry. By this process, the short bits are forced to adhere together and form one long straight piece of the required length. Thus paper of almost any size can be procured. The knife used in paring the pith into paper is in shape not unlike a butcher's chopper. It is well sharpened on a stone, and when not used, kept with the edge in a wooden groove, held firm to it by two strings round the wood and the knife. Before using it, the edge receives a fresh touch up on a small block of wood, usually a piece of the timber of *Machilus ramosa*, shaped like a large hone. The block on which the pith is cut consists of a smooth brick or burnt clay tile, with a narrow piece of brass on a rim of paper pasted at each edge, on which the knife is laid, and is consequently a little raised above the bare tile itself. The block is laid flat on a table, and the dried pith rolled on it with the fingers of the left hand, and then the knife laid on the brass rims with its edge towards the pith, its handle being held by the right hand. As the knife is advanced leftwards by the right hand, the pith is rolled in the same direction, but more slowly, by the fingers of the left. The paring thus goes on continuously, until the inner pith, about a quarter of an inch in diameter, is left, resembling somewhat the vertebral column of a very small shark, and breaking into similar concave-sided joints. This is used by the Chinese as an aperient medicine. The paring produces a smooth continuous scroll about 4 feet long, the first 6 inches of which are transversely grooved and cut off as useless. The rest shows a fine white sheet. The sheets as they are cut are placed one upon another and pressed for some time, and then cut into squares of the required size. The small squares made at Formosa are usually dyed different colours, and manufactured into artificial flowers for the adornment of the hair of the native ladies, and very excellent imitations of flowers they make. The sheets most usually offered for sale, plain and undyed, are about 3¼ inches square, and are sold in packets of 100 each, at rather less than one penny a packet, or a bundle of five packets for fourpence. The larger-sized paper is made to order, and is usually exported to Canton, whence the grotesque but richly-tinted rice paper paintings have long attracted the curiosity of Europeans.

Dr. Hepp describes a new genus of Lichen, under the name of *Guepinia*, after Professor Guepin, of Anjou, who first found it. *Guepinia polyspora* of Hepp is the Endocarpon Guepini of Mongeot. It was collected on Gneiss rocks near Meran, in Switzerland, in November, 1863, by Dr. Milde. Under the microscope, Guepinia shows characteristic spores, which exist to the number of 100 in one ascus, whilst Endocarpon (a genus to which Fries, Rabinhost, Schærer, and

Nylander have erroneously referred the plant) contains only eight spores in each ascus.

Dr. von Fritich, of Zurich, enumerates the following species of Lichens, as found by him on Teneriffe:—Lecanora flava var. oxytona; L. liparia, Ach.; L. orcina, Ach.; Parmelia elegans var. tenuis; P. dendritica, Pers.; P. parietina var ectanea, Ach.; P. caperata, Ach.; P. cæsia, Hoffm.; P. speciosa, Wulf.; Gyrophora vellea, var. spadochroa, Ach.; Lecidea geographica var. atrovirens; Cladonia furcata var. rangiformis.

Professor Koernicke, of Welden, near Konigsberg, describes a species of Melampsora which does great injury as a parasite to fields of flax in Prussia. Urocystis occulta is another parasite which destroys the rye in Prussia.

The vegetable nature of Diatoms has been inferred in part from their mode of reproduction, *viz.* by conjugation, as in Algæ. Of late the process has been actually observed in Navicula serians, N. rhomoides, and Pinnularia gibba.

In leaf venation we usually find that the lateral veins in lobed or toothed leaves are placed in the centre of the lobes, and correspond to the extremities of the teeth. In some cases, however, the secondary veins correspond to the sinuses of the leaf, as in Coldenia procumbens, Cratægus Oxyacantha, and Rhinanthus. Alphonse de Candolle also found the same to be the case in several species of *Fagus* (beech) as in Fagus Gunnii, Hook, and F. antarctica, Fost. Species, however, which are nearly allied, sometimes present different kinds of venation. In some species the same leaf shows this phenomenon,—some of the veins going to the teeth, others to the sinus. This is seen in Fagus alpina, Poepp. and Endl., and even sometimes in the common beech (*F. sylvatica*), and F. procera, Poepp. and Endl. This direction of the venation furnishes characters for distinguishing the Fagus Sieboldii of Japan and the Fagus ferruginea (*F. sylvestris, Mirb.*) from the Fagus sylvatica of the Northern European continent. In the beech of the United States, as well as that of Japan, all the lateral ribs and veins distinctly run in straight lines to the extremities of the teeth, which are always distinct and pronounced. In the European beech, not only are the teeth less distinct, and pass often into simple undulations, but the ribs are directed rather towards the sinuses, or, at least, are curved near the teeth, except those at the summit of the leaf. Other species having lateral veins directed to the dentations are Fagus obliqua, Mirb. F. Dombeyi, Mirb. F. fusca Hook, and F. Cunninghamii Hook. Palæontologists should beware of laying too much stress on the venation as indicating genera in fossil plants.

In the species of Sonchus, Professor Wolfgang, of Frauenfeld, finds that the pappus is formed of three or four rows of cellules, the oldest part of the hairs being their extremity. The very fine pappus of Sonchus under the microscope presents at its point asy stem of small hooks, formed usually of five or six cellules disposed in eight lines, recurved externally in the form of a hatchet. This may be a useful

character in distinguishing the species. He thinks that the pappus may thus furnish distinctive marks in the case of Sonchus arvensis, arboreus, asper, oleraceus, palustris, and tenerrimus. All these species, and especially the last two, show best this system of recurved teeth, whilst the pappus of Sonchus divaricatus is markedly different, and approaches near to the species S. Rabdotheca.

A recent monstrosity observed in *Anagallis arvensis* seems to show distinctly a placenta formed from the axis, and the outer integument of the ovule formed from a leaf. The axile bud was formed from the sepals and petals, as well as from the leaflets forming the ovary. The specimens showed very completely the foliaceous nature of the organs.

Professor Cramer, from numerous researches into monstrous ovules and into the development of normal ovules, maintains that those of *Primulaceæ*, *Compositæ*, &c., are metamorphosed leaves, and those of *Leguminosæ*, *Umbelliferæ*, *Ranunculaceæ*, &c., are metamorphosed parts of leaves.

The normal tetracarpellary condition of the siliqua in *Cruciferæ* has been recently advocated. Four carpels are actually found in *Tetrapoma pyriforme*. The normal number of stamens has been considered eight or sixteen—the latter number occurring in *Megacarpæa polyandra*.

Dr. Alexander Dickson has given the results of his investigations on Malope and Kitaibelia. He finds that the development of the andrœcium, as regards the evolution of the staminal lobes, is essentially the same in both genera. The andrœcium at first appears in both as an even rim-like cushion, pentagonal externally, surrounding the flattened termination of the floral axis, which appears as a pentagonal depression. The external angles of the staminal cushion in both genera alternate with the sepals. The essential difference between the arrangements in the two genera consists in this—that in Malope, the five angles of the central depression are superposed to the external angles of the cushion; that is to say, the sides of the depression are parallel to the outer sides of the staminal cushion; while in Kitaibelia, on the other hand, the angles of the central depression alternate with the external angles of the cushion, the sides of the depression thus lying crosswise to the outer sides of the cushion. This is seen long before there is any appearance of the carpels. In both genera five pairs of lobes alternate with the sepals, and extending longitudinally in a radial direction are developed on the surface of the cushion, which, as development advances, grows up as the staminal tube. In the subsequent stages, the author fully confirmed the statements of Payer as to the development of the stamens. On each of the lobes a longitudinal series of mammillæ appears in a centrifugal succession, and from above downwards. Later, each of these mammillæ branches into two lobes, each of which is developed into a stamen, with an ultimately one-celled anther; so that at last there are twenty rows of stamens, or, perhaps, more correctly, two rows of bifid ones. The carpellary groups form the sides of a pentagon, which in each genus corresponds to the sides of the original central

pentagonal depression or cavity of the staminal tube. Thus, these groups are oppositisepalous in Malope, and oppositipetalous in Kitaibelia. Payer had observed the difference in this respect between the two genera, but has in his 'Organogenie' inverted the statement of the facts, and, unfortunately, at some detail (pp. 34, 5). The development of five pairs, alternate with the sepals, of longitudinal series of mammillæ, and the subsequent development of each mammilla into two stamens, so exactly corresponds with what Payer has shown of the development of the stamens of Malvaviscus—where he has shown, besides, that the staminal tube is formed by the coalescence of five originally distinct staminal bosses or cushions superposed to the petals, similar to those in the majority of polyadelphous plants—that there can be no doubt that in *Malope* and *Kitaibelia*, as well as probably in all the other *Malvaceæ*, the andrœcium consists essentially of five compound stamens superposed to the petals. The difference in the development of the inside of the staminal cushion depends not on any difference in the position of the compound stamens, but probably on the constitution of the central depression—that is, of the termination of the floral axis; for it is easy to understand that the cells from which the carpellary groups are to be developed may be capable of conditioning the form of the cavity of the staminal cushion in accordance with the position of these groups. Such considerations, of course, do not at all go to explain why the carpellary groups should be differently placed in the two genera. An equally remarkable and somewhat analogous case occurs in *Tiliaceæ*, where Payer has shown that the staminal groups are oppositipetalous in Tilia, and oppositisepalous in Sparrmannia.

Professor Heer has examined the plants found under the ancient lacustrine habitations in Switzerland, more especially those discovered at Robenhausen and on the Lake of Pfæfikon. The vegetable remains are almost all carbonized. At Robenhausen, Wangen, Lake Constance, Moosedorf, in the centre of Berne, the Isle of St. Pierre, and other localities he finds among cultivated plants Triticum vulgare, L., two varieties, T. turgidum, L., T. monoicum, L., T. dioicum, L., T. Spelta, Hordeum hexastichum, L., H. distichum, L., Avena sativa, L., Secale cereale, L. The culture of the last (common rye) appears much later in history than that of the other cereals. Setaria italica is also found, which, according to Cæsar, was the principal cereal of the ancient Helvetians. In the more recent habitations three Leguminous plants are found—the common bean, the common pea, and the lentil. Among the fruits found are apples, and the drupes of Prunus insititia, P. Padus, and P. spinosa. A species of flax allied to Linum perenne is also found. Among the remains of wild plants are the raspberry, strawberry, elder, water chestnut (Trapa natans), hazel, beech, Silene, Papaver Rhœas, juniper, Scotch fir, spruce, yew. Also seeds of aquatic plants, such as Scirpus lacustris, Ceratophyllum demersum, Potamogeton, Polygonum Hydropiper, Galium, Pedicularis, Menyanthes, Nymphæa alba, Nuphar luteum, and N. pumilum.

From careful examination of two fossil cones of Lepidodendron,

Professor Schimper considers the plant more nearly allied to Selaginella than to Lycopodium. A specimen of Lepidodendron fruit was purchased about fifteen years ago by a physician of Lower Alsace, from an antiquary in Paris, who did not know the locality whence it had been taken. The upper half of the specimen belonged to Robert Brown (*Botanicorum facile princeps*), who bought it for about 700 francs, whilst the lower half came into the possession of Professor Schimper. Another equally good specimen has been recently found in a valley of the Pyrenees, near to Barèges.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

First among the additions which have been made to our knowledge of Chemistry since the date of our last 'Chronicle,' we must notice Mr. Graham's continuation of his experiments with Silicic acid and other colloid substances.*

It is impossible to condense into a short space this highly important paper, in which a series of most interesting facts, arrived at by a long course of investigation, are expressed in the fewest possible words. We have no option but to refer the chemical reader to the original, which will be found in the Journals indicated below.

A good deal has at different times been written about a *passive state* of metals, or a condition in which they are insensible to chemical agents; and a day has been looked forward to when iron would never rust, and silver never tarnish. That day now appears more distant than ever, for Dr. Heldt has shown that the facts on which this hope was based admit of a very simple explanation. The author shows that by certain agents the surfaces of metals become coated with an insoluble compound which prevents further action. But other agents remove this covering, and the action again proceeds.†

The preservation of iron ships is a subject to which we have before alluded, when speaking of the patent of Messrs. Johnson and Calvert.‡ The subject has recently been investigated by M. Becquerel,§ who finds that it is not necessary to cover the iron plates entirely with zinc, but that bands of this metal placed at intervals around the ship suffice to protect the iron from oxidation.

We may refer, in passing, to the discussion of a question of great industrial importance which has lately engaged the attention of the French Academy of Sciences.‖ It is the question, By what agency is iron converted into steel? M. Margueritte contends and quotes ex-

* 'Proceedings of Royal Society,' vol. xiii., with additions in 'Chemical News,' vol. x. pp. 97–109.

† 'Les Mondes,' t. vi. p. 413.

‡ 'Quarterly Journal of Science,' vol. i. p. 119.

§ 'Comptes Rendus,' Oct. 31, 1864.

‖ 'Comptes Rendus,' t. lix. pp. 185–376 et seq.

periments to prove that it is by the agency of carbon alone. Iron, he tells us, exposed at a red heat to an atmosphere of carbonic oxide (the presence of nitrogen being carefully excluded), assimilates carbon, is converted into steel, and carbonic acid is formed. M. Caron, on the contrary, without denying that carbon may have some influence on the result, contends that the presence of nitrogen is absolutely indispensable, and affirms that cyanogen is a true agent in the conversion. A paper, which we shall have to notice in the Proceedings of the Chemical Society, throws some light on this question.

MM. Reich and Richter have now obtained a sufficient quantity of their new metal, Indium, to enable them to determine its atomic weight and principal chemical properties. The former must be regarded as merely approximative, for the methods employed were such as could hardly lead to conclusive and accurate results. Of three not very closely concordant determinations, the authors prefer that which gave the number 463·4 O = 100, which corresponds to 74·14 O = 16. Indium is a white metal, very soft and ductile, and which does not easily tarnish. Its specific gravity is 7·277 at 20·4° C; and its fusing point is about the same as that of lead. It is easily soluble in acids. Sulphuretted hydrogen does not precipitate the sulphide from acid solutions (except acetic): ammonia throws down from them the hydrated oxide. Carbonate of soda throws down a granular carbonate. The most characteristic tests for Indium are the spectrum experiment, and the blue colour which the chloride and sulphide easily communicate to the flame of a Bunsen's burner.*

Speaking of metals we may mention a process for covering metals with bright layers of each other, which has recently been devised by M. Weil.† The author makes an alkaline solution of the metal to be deposited, and adds to this some organic matter, such as tartaric acid or glycerine. The metal to be coated is placed in this solution, and if necessary a weak voltaic current is set up by placing a piece of zinc in contact with the metal. Iron and steel can in this way be firmly coated with copper, beautifully varied effects of colour being produced according to the thickness of the layer of copper. Zinc, nickel, and silver, may also be deposited on other metals by the same process.

A new blasting powder has been introduced, which has been analyzed by Dr. H. Schwarz.‡ The percentage composition of the powder according to the analysis will be as follows: sulphur, 10 parts; charcoal, 15 parts; nitrate of potash, 56 parts; nitrate of soda, 18 parts. The difference is made up of moisture. Such a composition will, of course, be cheaper than ordinary gunpowder.

In organic chemistry, the progress in which is perhaps more rapid than that made in any other branch of science, we have nothing to report which would interest the general reader.

* 'Journal für prakt. Chemie,' Bd. xcii. s. 480.
† 'Comptes Rendus,' Nov. 7, 1864.
‡ 'Bulletin de la Société Chemique de Paris,' t. ii. p. 391

Proceedings of the Chemical Society.

The first paper read this session was by Professor Wanklyn, "On Valeryl, the Radical of Valerianic Acid." This paper disclosed a very unexpected reaction. When Valerianic Acid is acted upon by sodium, the author found that ethylate of sodium and valeryl are produced. A similar separation of the acid-forming radical in other ethers induces the author to believe that the acid-forming radical is the base in some ethers, and that it would be more correct to describe valerianic ether as ethylate of valeryl, than as valerate of ethyl, and acetic ether as ethylate of acetyl instead of acetate of ethyl. In a subsequent paper, read November 17th, the author returned to this subject, and developed his views on the "Nature of Compound Ethers." He divides these bodies into three classes—*viz.* (1) Those in which the acid-forming radical is replaceable, as in the cases mentioned above; (2) those in which the alcohol radical is replaceable, and which he regards as true salts of the alcohol radical, such as iodides, bromides, chlorides, &c., of ethyl, and the rest; and (3) such bodies as common ether, the anhydrides, &c., in which the radicals are equally replaceable.

A very important paper, bearing on the Constitution of Steel, was read at the meeting on November 3rd. It was entitled "On the Existence of Nitrogen in Steel," and detailed the results of a large number of experiments made by Messrs. W. Baker and Graham Stuart. We may say, shortly, that the authors experimented with the best varieties of Sheffield steel, with Bessemer's, and with the celebrated *Spiegeleisen.* The results of the investigations, most carefully conducted, show that nitrogen is not an essential constituent of steel. It was found to be present in a few specimens, but the quantity was too minute to have any appreciable influence on the quality of the steel.

Another paper, by Mr. W. Baker, was read at this meeting, "On the Occurrence of Nickel in Lead, and its Concentration by Pattinson's Process." The author finds that nickel is commonly present in English lead, and that a considerable proportion may be removed by Pattinson's process. Thus, 5 tons of lead, containing 2 oz. 4 dwts. 11 grs. per ton of nickel, were submitted to the process. Four tons and a half were removed as crystals, and this lead, on analysis, showed the presence of only 1 oz. 10 dwts. 1 gr. of nickel per ton. Copper may also be separated from lead by the same process, but the quantity at starting must not exceed 10 oz. per ton.

At the same meeting, Professor Church read a paper "On the Blue Colour of Forest Marble;" and another "On the Effects of Ignition on Garnets," &c. With regard to the former: a block of Forest Marble is of a fawn colour externally, while the interior is of a bluish-grey colour. This has been ascribed to the presence of iron in the form of peroxide without, and protoxide within. Professor Church, however, showed that the blue colour of the interior is due to the presence of bisulphide of iron, which on the exterior becomes converted into sulphate of iron, and this by reacting on the carbonate of lime in the presence of air, forms sulphate of lime and hydrated peroxide of iron.

As regards the effects of ignition on garnets, &c., Dr. Phipson has

asserted that these stones undergo expansion at a red heat, but gradually return to their normal dimensions; and after a considerable interval of time assume their original specific gravity. This statement Professor Church cannot confirm. He found, in fact, that many stones of the family did undergo expansion when exposed to a heat sufficiently strong to fuse them, but that they remained permanently reduced in density in consequence. At a red heat he found them all practically unaffected. The Professor returned to the subject at the meeting on December 1st, and confirmed the results he had previously announced.

Another valuable practical paper was read on November 17th, by Dr. Marcet. The subject was the "Brine of Salted Meat." The practical object of this paper was to show how large a quantity of nutritive matter was wasted in the brine, and again when the salted meat was soaked in water to prepare it for cooking. In both cases the waste was easily avoided. To recover the nutritive matter from the brine the author evaporates the latter at a moderate temperature to one-third its bulk, decants the liquor from the salt deposited, and then removes the remainder of the salt by dialyzation. In this way he obtained a liquid which made a good and cheap soup. To prevent waste in salting, the author proposes to cut the meat into small pieces and place it with ten or twenty per cent. of salt, in sausage skin or bladders, and then to immerse these in a strong brine, and there leave them until the meat is sufficiently impregnated. The skin, we ought to say, must be quite full. When the meat is required for use, the skins have only to be placed in fresh water for the salt to dialyze out. The author pointed out that joints salted in the ordinary way might be made to retain much nutritive matter if they were closely wrapped in skin or bladder before they were soaked. A practical point of less general importance was a suggestion by Dr. Marcet, that brine might be used as a source of inkreat, kreatinin and lactic acid.

V. ETHNOLOGY.

(Including the Proceedings of the Ethnological Society.)

A CHRONICLE of the progress of Ethnology is not the easiest thing to write, for the simple reason that it is very doubtful how and when progress is really made. It is perfectly true that we have many indefatigable skull-measurers, voluminous writers, readers of papers, and pamphleteers, both unitistic and pluralistic, or, if it be preferred, monogenistic and polygenistic; but, as yet, there is for Ethnology neither any such absolute definition of terms, nor any such agreement as to bases of arrangement and classification as characterize every other established science. What is considered right to-day, is too often considered wrong on the morrow, and even its very name is a subject of dispute, and strenuous efforts are being made to merge the long familiar cognomen of the "Science of Races" into the more modern and less euphonious designation compounded by those who

assert it properly to be the *de facto* science of men and monkeys. Perhaps there is not much in a name, and if there were anything better done in Anthropology than in Ethnology, we might not feel disposed to quibble more about the one than the other, any more than we should over Geognosy and Geology. It is not, however, certain whether we ought to regard the study which Ethnology pursues as *the* "Science of *Man;*" it is much to be questioned whether we should not begin at least with the "study of *Races,*" for whether all mankind came from a single source, or from a plurality of origins, it is equally a fact, equally certain, that numerous *races* of men *do* exist. If then, we can classify, and describe under an accurate system of terms those races which *do exist*, there will have been established the rudiments of a proper science, which can be expanded and elaborated in all directions. But whilst one person describes a Celt as having a round head, or brachycephalic skull, and another insists that his head was long and his skull dolichocephalic, it would be idle to contend that even the proper foundations of the Science have as yet been clearly established. Nor is Anthropology in any better position. All that has been done under either name—valuable though much of it be—has been in a high degree erratic and unsatisfactory. Nor, in saying this, would we in any way detract from the valuable labours of Blumenbach, Pritchard, Latham, Knox, Nott, and Gliddon, Crawfurd, Broca, and many others, living and dead, not the least of whom, and, to the mind of the writer, the most philosophical of all, is Georges Pouchet, whose concise and logical work 'Sur la Pluralité des Races Humaines,' deserves to be everywhere read, albeit that it is violently opposed to the ordinary faith in the unity of mankind. Of this remarkable book a second edition was recently published, and was almost immediately followed by a translation under the direction of the Anthropological Society of London, but which, to the regret of every one, has proved so full of errors, both of translation and in the rendering of the author's meaning, as to have been universally condemned by the critics of the periodical press. Perhaps it is this fear of admitting a plurality of origins for the varieties of mankind that has been the greatest cause of obstruction to the progress of Ethnology as a science; certainly the hard tuggings in opposite directions by the monogenists and polygenists have been the primary source of all the confusions and contradictions with which both Ethnology and Anthropology abound. Both views should be candidly and fairly discussed, unbiassed by any religious faith or any theological considerations. The chemist does not work in his laboratory Bible in hand, why then should the Ethnologist any more than the Geologist be restricted to seeing everything through the first chapter of Genesis? If all human beings, black, red, and white, be the children of one primitive Adam, let us philosophically prove it by the inherent force of truth elicited from facts by logical deductions. If the various races come from different origins, and bear, like species of plants and animals, the impress of different natures and adaptations for different uses, then let it be so admitted frankly and fearlessly, when facts and proper arguments have *positively* proved it.

So far the papers discussed during the present session before the Ethnological Society of London have been mostly papers previously read at the Bath Meeting of the British Association, and have contained neither novel nor very important matter. The most suggestive paper has undoubtedly been one of Mr. Prideaux, "On the Principles of Ethnology," in which he pointedly draws attention to the unsatisfactory condition of terms and first principles, and does not shrink from declaring that even "the foundation-stone of a durable and scientific edifice has yet to be laid." Nor does he leave the subject as Ethnological subjects are too often left, with laments only of the want of something better, but he shows—if not a certain remedy—at least how an amelioration of matters may be begun in a proposed *decisive attention* to the characteristics of *existing races.*

Just as geologists, by studying existing phenomena and living creatures, have interpreted the phenomena of past ages and past creations of organized beings, so he would have the foundations of the interpretation of mankind's past history and development rooted in the phenomena of the living human beings swarming over every part of our sunlit globe, and contemporaries of ourselves. Amidst all the amalgamation of races, he argues, that have taken place, nothing is more certain than that *types of great antiquity* are always present, and in great numbers and very tolerable purity, amongst our populations. No indiscriminate blending of blood takes place, producing an homogeneous offspring according to the numerical proportions, or the relative vital force of the component races, and thus extinguishing the recurrence of the original types. But on the other hand we cannot take upon ourselves to say that this can never be effected in a long period of time in a mixed race, subjected to the same climatic conditions. • The first task to be undertaken, in order to conquer a solid basis for the science, is the recognition and identification of existing types by which we are surrounded. This accomplished, the study of the phenomena, presented by living contemporaneous populations, follows next. What changes are being effected? what evolutions are in progress? what laws have governed the production of the type-forms recognized amongst them? In the answers to these questions will most probably be found the key to the history and transmutations of the past.

Another paper deserves also some special mention. Dr. Shortt's "account of some rude tribes, supposed to be Aborigines of Southern India." Such accounts given in anything like an intelligible form, are always interesting, especially when habits, legends, and personal incidents are graphically detailed; but when features, weight, stature, and measurements are recorded with precision, the data become valuable additions to the general stock of useable and comparable information.

In these latter particulars, Dr. Shortt always exhibits such praiseworthy order and care, as to make us always feel certain of his facts, although we may sometimes feel doubtful of his comparisons, as, for example, his association of the Yenadis, and other rude tribes of Southern India, with the Mongolian type. Of the several tribes noticed by him in this paper, the most interesting are the Iroolers of

the vicinity of the Ramagherry Hills, and who may really be a descendant remnant of the Aboriginal inhabitants of India, before it was overrun by the present dominant Hindu race. But the Iroolers even here exist no longer in untainted purity of manner. Brahminism has tinged their religious feelings, and Nagalapooram, the village in which they chiefly reside, is celebrated for its temple and dancing girls. The annual *Sootia Poojah*, or worship of the sun, is there celebrated with considerable pomp; and anxiously do the deluded people watch the rays of the sun enter the temple and glow on the uncouth features of the senseless log-god in its midst. Great is their joy, and happy the omen; the worshippers being too ignorant to understand that through a loop-hole cunningly constructed the sunbeams enter on this one day of the year, and attributing to their insentient idol the working of so wonderful a miracle.

In his paper "On the Fixity of Type," the Rev. Mr. Farrar argued that from the dawn of history to the present time, an extraordinary fixity of type had characterized all the recorded races and varieties of mankind, and which was not accountable for by the effects of climate, custom, or food. He did not, however, touch, in anything like a scientific manner, the great point of *how* diversity of race has been produced—for assuredly climate, food, and other circumstantial conditions must be admitted to have operated, if the theory of the unity of mankind is to be maintained. It is useless to adopt Mr. Reginald Poole's clever argument with respect to the Egyptians for a wider range, and to urge that as since the dawn of the historic period to the present time, no symptoms of any change of type in the same race, however slight, can be detected, therefore no change had ever previously occurred, without giving in an adhesion to the doctrine of a multiplicity of race-origins. Nor, perhaps, can this line of argument be unanswerably urged, for just as, notwithstanding between the extremes of the earth's wide orbit although we can get no parallax for a distant twinkling star our senses assigned to it a remote but definite distance, so the rays of the gradual change or modification of a human species may come from so remote an age as to appear to our limited investigations, strictly parallel and non-divergent. Suppose climate an effecting cause of modification, how few races or species are at at all affected by variations of one degree of temperature, and yet how long a period would the supposed secular cooling of our globe take to bring down the general temperature of the earth that one degree. A hundred thousand years? If so, and it would not be less, to get the influence of one degree of cooler climate upon a human species, —and how little that would be—it would take fifty times the whole historic period. How difficult, then, to determine what is fixity of type or what is slow but certain change.

VI. GEOGRAPHY.

(*Proceedings of the Royal Geographical Society.*)

The regions of geographical discovery and survey of which we have received accounts during the last six months, have been comparatively few. Central Africa seems to monopolize almost all those enterprising discoverers, who are able to make a hobby of this science, to spend their season (of two or three years) in exploring, and to return to spend another season in book-writing and in lionizing in the drawing-rooms and discussion chambers of London. From somewhat farther afield came M. Vámbéry, the visitor of Samarcand; Mr. W. G. Palgrave, whose paper we epitomized in a former number; Viscount Milton from the Rocky Mountains, where he spent in toil months that might have been passed amid every luxury in England, and Mr. John Macdowall Stuart from Central and Northern Australia. We have besides this an account of the settlement of a new colony on Cape York, of the laying the electric cable in the Persian Gulf and Mesopotamia, with a description of the islands of Kishm and Ormuz, and of an attempt to carry a railway over the Serra do Mar in Brazil.

The discoveries in Central Africa have been diminished by the shocking and untimely death of Captain Speke in the midst of the ovation he so well deserved; by the decease, on their travels, of the Dutch ladies who had penetrated to the Soudan, but had been obliged to return; by the loss of Dr. Schubert, who was in search of Dr. Vogel, and by that of M. Jules Gérard. On the other hand, we now have in England Dr. Livingstone and Captain Burton, in addition to Dr. Kirk, Mr. Galton, and others, who were here before. By these, each new discovery is canvassed with minuteness that borders sometimes upon cavilling. Scientific researches require coolness and calm discussion, and mistakes may well be acknowledged with frankness or pointed out with gentleness. Captain Burton, formerly consul at Fernando Po (where he is to be succeeded by Mr. Charles Livingstone, brother of Dr. Livingstone), but lately promoted to a like post at Santos, in South America, is said to be about to employ the six months' leave of absence which he obtains on this promotion in the exploration of a certain portion of the continent which of late years he has penetrated. In the meantime he gives to the world two handsome volumes on his late expedition to the King of Dahome, undertaken with a view of diminishing, if not putting an entire stop to, the brutal so-called "Customs." Though unsuccessful in the main object of his mission, he has written a most interesting account of the manners and peculiarities of these barbarians. The Grand Customs and Yearly Customs were witnessed by Captain Burton, and the account of these and of the Amazonian army, naturally form the most interesting and original portions of his work. This army of Amazons is computed at 2,500, and is divided into razor women, elephant huntresses, bayonet women, blunderbuss women, archeresses, &c. They mostly have a great tendency to fatness, nevertheless they are

indefatigable dancers, and march with a most military swagger. The women are originally of a very masculine character, and the style of life they lead adds to this appearance. About a third have been originally married women, but have been presented to the king (whose wives the whole 2,500 are supposed to be), by their husbands whom they have maltreated or to whom they have been unfaithful. Notwithstanding the presumed marriage with the king, when the army was lately about to march against Abeokuta, about 150 of these *soldiers* who had no right to be so, were found to be pregnant. Under these circumstances, they have to undergo a form of trial with their paramours, when frequently the guilty parties suffer death. The present king, however, is somewhat more merciful than his predecessors, and his jealousy is appeased by some less grievous punishment.

Though not actually witnessing the execution of any human victims at the Customs, Captain Burton saw enough to convince him of the enormous amount of blood spilt on these occasions. The whole subject is a curious one, and those who wish thoroughly to understand the extraordinary nature and origin of these sacrifices, must study the volumes themselves: we can only give a brief outline of some of the performances. The original idea is that of filial piety. The deceased monarch requires to be accompanied to the land of shades by his principal and other eunuchs, by various wives and a variety of other attendants. Accordingly victims who would amount to a small army, and may amount to 500 in number, are despatched at the Grand Customs. But besides these, others are sacrificed every year. Under the present king these amount to about forty men, and as many others are murdered by the Amazons, so that nearly eighty persons besides the first fruits of prisoners of war and all criminals are butchered yearly by these savages to fulfil their notions of filial piety. On the "Evil Night," moreover, all who make their appearance out of doors, do so at the risk of their lives. The present king, Gelele, is rather more inclined to these sacrifices than his father Gezo, who had reduced them considerably. The Amazon army had been much diminished by the former attacks on Abeokuta, and had never entirely recovered its numbers. Still these female warriors were in high spirits with regard to the war which was just impending when Captain Burton was at Dahome. The *captainess* of the Beauty Company, in an address to the king shortly before the expedition, with much eloquence, if eloquence consists in action, declared, after she had cut off the head of an imaginary corpse, "Thus they would treat Abeokuta." But Abeokuta refused to be thus treated, and the Amazonian army was cut to pieces, and the king narrowly escaped with his life. It is not likely that this kingdom of Dahome will ever rise again to its pristine condition after this terrible blow.

The travels of Dr. Livingstone, as well as his later movements, we abstain from relating, since his work on this subject is promised early in the year. This will be accompanied by the narrative of Mr. Charles Livingstone's expedition to the Zambesi and Lake Nyassa. It is, however, not likely to pass without severe criticism, as almost every African explorer has his own opinion on the direction of every river,

and the boundaries of every lake, whilst one or two Englishmen seem inclined to back the explorations of the Portuguese in preference to that of their own countrymen. We must hope that this devoted traveller will profit by the remarks made on his former work, and will arrange his present production in a more logical manner, and take some pains about the actual composition, so as to give his work a more readable character than the former. One of Dr. Livingstone's former companions, Mr. Thos. Baines, the artist of the expedition in 1858, has now published an account of his journey from Walvisch Bay on the Western Coast to Lake Ngami, and thence to the Victoria Falls on the Zambesi, undertaken in the years 1861 and 1862. The route described is not one of any great interest, as it has almost entirely been traversed before, but the word-pictures of the artist make us hope that the actual sketches may some day find their way to the public eye. At the same time the work itself is somewhat tedious, arising from the fact that the author has been unable to act as editor, otherwise we may be sure that much which was interesting enough when first sent home, would have been cut out, and that repetition of similar every-day occurrences would not be chronicled with the fidelity of the writer of a Court Circular. Mr. Baines's collection of Natural History Specimens will no doubt add much to our present knowledge, at the same time his want of scientific nomenclature prevents many of his descriptions from being of such use as they otherwise might become.

Other travellers are pressing in upon this continent. M. du Chaillu, the report of whose death turns out to be untrue, is advancing towards the interior from the western side. The upsetting of a boat had caused the loss of his instruments, but these have been replaced. Though M. du Chaillu lives, Dr. Schubert of Leipsig, attached to the expedition in search of Dr. Vogel, and Madame Tinné and her maids, have forfeited their lives in the pursuit of science; Baron von Heuglin, however, continues the researches begun by her in spite of the obstacles thrown in his way by the slave merchants and other dealers, who are unwilling that too much light should be thrown upon their nefarious traffic. He has already discovered several isolated mountains, and one range to the west and north-west of the Quola country. He contributes various ethnological, linguistic, and geological facts to the previous knowledge of the kingdom. It is sincerely to be hoped that the slave trade of the interior, which is really the greatest obstacle to research in these parts, should be checked by the official interference of European authorities —a measure much easier of execution and much more useful in its fulfilment than the watching an extensive coast for the departure of slaves. The recently-announced death of another brave adventurer, Jules Gérard, who attempted to penetrate into Central Africa, from the West Coast, is also to be sincerely regretted. Although completely unsuccessful in every attempt to enter the interior, and notwithstanding that his accounts of the places where he sojourned have been meagre, we think it right to refer with regret to his untimely end.

From Australia the news is but small. A new town has to be

added to our map, *Point Somerset* (named after the First Lord of the Admiralty), at the extreme north of Cape York, which is itself the northern portion of the continent. The new colony lies on a peninsula of the main land, immediately opposite Albany Island. It will form an important station for the mails from Melbourne, Sydney, and Brisbane, in their way northward, by way of Batavia, to meet the China mail. The whole of the northern portion of this peninsula promises to be fertile and salubrious to Europeans. The colony itself, which includes the whole of Cape York, has been chosen especially with a view to the health of the inhabitants and officials. It is open to the sea breezes, both from the Pacific and the Indian Oceans. Both round the coast, and across the country by the Flinders, and other streams, the settlements are creeping on to the Gulf of Carpentaria. The geology of the inland portion of the colony of Queensland deservedly attracts much attention amongst the colonists. Mr. Coxen has written a paper, read before the Philosophical Society in Brisbane, detailing the results of a very extensive and careful survey. The principal formations are primary or secondary, and those of most practical importance are either decomposed trap mixed with calcareous sand over shales, making a most fertile soil, or carboniferous strata, which latter are said to be very plentifully distributed.

Central Africa having been so frequently discussed, and the subject having received all the ventilation which it is possible to bring to bear upon a subject where the inductions must be from so few instances, it is refreshing to find oneself on new ground, and to traverse with M. Vámbéry the districts of Central Asia. Old as the subject is, it becomes new from its very antiquity. The last traveller who has left us Englishmen an account of much of the ground that this distinguished Hungarian has travelled over was Marco Paulo. Ruy Gonzales de Clavijo, Spanish Ambassador to the Court of Timour Khan, visited Samarcand in the zenith of its splendour, but at such personal inconvenience that his narrative can hardly be expected to give us a fair description of the place. Timour was so anxious to get the Spaniard to his palace in time for a particular festival, that the latter was compelled to travel at a pace which killed one of his companions, whilst he himself was worn out. On his arrival, he, the abstemious Spaniard who never touched wine, was compelled to be present at banquets from which but few guests departed sober. Nevertheless he describes the city as containing very fine buildings, besides many which, though not completed, gave great promise of splendour for the future. Very different is M. Vámbéry's account. His description has lately been published by Mr. Murray, previously to which the main outline was read in the form of a paper before the Society, and additions were made *vivâ voce* to the written document by the gentleman himself, who overcame, for the benefit of the meeting, his natural repugnance to speak a language he was far more accustomed to read than to hear or pronounce. His linguistic triumphs in Turkish, and Arabic, and other Oriental tongues, demanded and received some indulgence from an English audience.

The great desire of M. Arminius Vámbéry, like that of many of his countrymen, was to throw some light upon the linguistic connec-

tion of his native tongue. Thinking that the dialects of Central Asia would assist him in this scientific research, he settled for four years at Constantinople, studying as a Mollah or Divinity Student in the colleges there. Thence he passed into Asia, arrived at Teheran on the 13th of June, 1862, and at last, after nine months' sojourn there, joined a party of twenty-four dervishes who were returning from Mecca to their own country. This even was a matter of some difficulty, owing to his dress and colour. In the former matter he soon conformed himself to the habits of his companions, and became even the dirtiest of the fraternity. Thenceforth he journeyed onwards in the disguise of a Moslem pilgrim, or holy man, whose blessing was craved by, and for a consideration granted to, many a robber chieftain, and whom women of the greatest beauty, and girls even, desired to embrace. With a pilgrim's staff and a copy of the Koran he crossed the desert to Khiva. He stayed among the Turcomans a month, observing the extraordinary liberality and hospitality, combined with cruelty and tyranny, which make up their character. His visit to Khiva is not so interesting, since it is well known, from having been visited by Captain Abbott and Mr. Thompson. Continued suspicions pursued the unfortunate traveller on his road. He was constantly being taken for an English, Russian, or Persian spy. At Khiva, the Prime Minister had been at Constantinople, and consequently this great authority was easily persuaded that the traveller, who had acquired a surprising command of Arabic, and a thorough knowledge of the Mussulman ceremonial (which he exemplified by blessing the Geographical Society in true Oriental style), was really what he professed to be, a true Mollah from Constantinople, seeking the tomb of some holy man. From Khiva they journeyed to Bokhara, along the left bank of the Oxus. In order to escape a party of Turcomans coming to plunder them, they were obliged to flee into the desert called Djan-bateran (the destroyer of life), where they encountered horrible thirst, and from this cause lost two of their party. The description of the death of one of these men, and of the fear of a like fate that invaded M. Vámbéry, is worthy of the attention of sensation novelists, so horrible and so uncommon does it appear. In Bokhara our traveller encountered fresh danger from political espionage, but by a little tact and impudence he compelled the vizier to acknowledge him as a renowned dervish, holding out threats of eternal punishment if he suspected him. The reigning prince Moozaffar-ed-din, son of the murderer of Conolly and Stoddart, is described as a man of a pleasing countenance and good disposition, "but forced for political reasons to commit many tyrannical acts." After a month at Bokhara, just as he was departing, he was summoned to an interview with the monarch himself, with whom again a good share of audacity succeeded in procuring recognition and dismissal. Thence the journey to Samarcand was through a thickly-peopled and well-wooded country, abounding in villages and towns, but the capital itself was disappointing, not only for its present insignificance, but also for the few relics of its former reputed splendour. The Medresses or colleges were the most remarkable buildings, and one erected by the wife of Timour surpassed every other building

in magnificence. The palace and tomb of Timour must attract attention : his throne consisted of a block of greenstone which was brought from Broussah, but by what means it is difficult to imagine. In the burial-place of Tamerlane his first teacher is buried next to the conqueror, and around him his children, whilst beneath the minutest details are exactly copied. After ten days at Samarcand, M. Vámbéry proceeded to Karshi and thence to Herat. In this place, which is tolerably well known, he considered himself safe ; still he was suspected, and had great difficulty in getting farther, but his journeying from this point was over known ground, and therefore it need not be further related.

The electric telegraph from India to Europe adds an interest to localities otherwise of but little importance. It is not improbable that it may be the means of opening up the navigation of the Euphrates, now for some years stopped. The Isles of Kishm and Ormuz, at the mouth of the Persian Gulf, were visited by Lieut.-Col. Lewis Pelly, Acting Political Agent in that neighbourhood, in December, 1863. The principal natural curiosities are naphtha springs and salt caves of a height and length of from 200 to 300 feet, with a span of 60 to 70 feet, in hills varying from 300 to 600 feet in height. The salt in the mass is beautifully streaked, whilst large crystals hang in festoons from the roof, and are of a snowy white. The salt is carried on the backs of asses and camels to the shore, whence it is exported to Calcutta and the east of Africa. The Isle of Ormuz, though said to be the site of a magnificent city, shows no remains that would indicate such a fact.

The Royal Geographical Society.

In opening the present session of the Geographical Society, the President, Sir Roderick Murchison, drew the attention of the Society to what they must expect to form the staple of their discussions during the ensuing months. Central Africa still affords the widest field for discovery : it moreover possesses many points of attraction to travellers, it is the nearest of unexplored lands, affords any amount of difficulty in travelling that suits the investigation, has enough of romance in it to dazzle the mind, and its configuration is a problem not to be solved by analogy, but at the same time throwing some light on the similar continent of Australia. In the loss of Speke, we mourn not only the man who has done much, but we regret one who was to have done much more, who, whilst Livingstone remained in England, might have carried on his investigations in Africa. An obelisk, similar to that erected to Lieutenant Bellot, is to commemorate his worth. The misfortune of his death was the only thing to mar the complete success of the geographical portion of the proceedings of the British Association. Amongst many excellent ideas struck out by that concourse of scientific minds, one very advantageous suggestion was made—*viz.* that the Government should be

requested to furnish the vessels of H. M. navy with the deep-sea sounding apparatus, such as was used under Sir L. McClintock, in the 'Bulldog,' and that the results of the researches that might be carried on, should be recorded in the Hydrographic Department of the Admiralty, and the specimens forwarded to the Geological Museum.

The first memoir of the session, "On the Head-waters of the Nile," by Captain Burton, is referred to below. The President alluded to the labours of Dr. Beke, Mr. Findlay, Mr. James Hogg, and Mr. Vaux, on various points connected with this interesting question. Mr. Consul Petherick had obtained news of Baker, who was said to have lately visited some great lake, probably Luta Nzigé; but further information was expected soon. The movements of Livingstone were next sketched, and the capabilities of Dr. Kirk rehearsed.

A letter from M. Du Chaillu, mentions that he was awaiting the arrival of new instruments, provided by the Society, to replace those lost by the upsetting of a canoe as he was disembarking in the Gaboon territory. In the meantime, he had made a collection of objects of Natural History, including several stuffed and one live gorilla, for the Zoological Society, which, however, has since died, besides upwards of 4,000 insects, including 500 butterflies. The notes of the late Richard Thornton, referring to the ascent of Kilimandjaro by Baron von der Decken, have been abridged by Mr. Bates to such a size, that they might be read before the Society. In the meantime, the Baron, who, it will be remembered, received the gold medal of the Society, is preparing to enter Africa by way of Zanzibar, when he received, through Sir H. Bulwer, Her Majesty's Ambassador at Constantinople, a firman which will facilitate his progress in the countries influenced by the Egyptian authorities. The President concluded by congratulating the Society on its prosperity, and the number of candidates for the fellowship.

A paper, by Captain R. F. Burton, in a tone, as was only seemly, of great moderation, combated the conclusion that the whole question of the sources of the Nile had been solved. Whilst acknowledging the many noble qualities of Captain Speke, he contended that the sheet of water known as Lake Victoria Nyanza, might, for all that was known to the contrary, consist of many smaller lakes; that the difference of level was irreconcilable with a connection with the Nile; whilst Lake Tanganyika might be 1,000 feet or more higher than the level assigned to it, inasmuch as the instrument by which it was measured was a common shilling thermometer, liable to be moved from its box-wood frame by the motion of a journey. Tanganyika then might flow into the Luta Nzigé, and thus become the head-water of a large branch of the Nile. The Mountains of the Moon, which were marked in Speke's map in 1859, did not exist, and were, in fact, originally an exaggeration of the engraver. The opinions of Captain Burton met with considerable support among the numerous African travellers who were present at the meeting, whilst a very general feeling seemed to exist in the meeting that much remained to be done in the way of elucidation of this vexed and important question.

Viscount Milton, accompanied by Dr. Cheadle, has been exploring the means of communication between Canada and the new colony of British Columbia. The results of these researches were laid in the form of a paper before the British Association, and have since been brought before the Royal Geographical Society. The party started from the Red River settlement westward, following in the main the direction of the Saskatchewan to Jasper House, then they traced the Athabasca and the valley of Myette, and across the watershed of the Rocky Mountains by the Leather Pass. The slopes were so gradual, that the travellers could scarcely imagine that they had crossed the ridge. They descended by the Fraser river to Tête Jaune's Cache. Here they met with great difficulty from the overflowing of the river—for days the water was up to the girths of their horses, or they had to climb the precipitous sides of the valley, where they could find no rest. They thence followed the track of some previous emigrants, crossed the Canoe river (a tributary of the Columbia), and then followed the Thompson, until the track they had been pursuing came to an end. Their predecessors had floated on rafts down the stream, thinking it hopeless to cut their way through the dense forests. These determined travellers, however, persevered. After a month, their provisions failed; they were reduced to pemmican and flour, and finally to dried horseflesh. At the end of three months from their setting out from Fort Edmonton, on the Saskatchewan, they arrived at Fort Kamloups, in British Columbia. The travellers consider that roads and even railroads might be carried over the district they traversed, and the advantages they sum up as follows:—(1) That this route runs well within the British possessions, and removed from the United States boundary; (2) that the Indians inhabiting the route are friendly; (3) that it is the most direct route between the gold regions of British Columbia and Canada; (4) that it is easier, and at a less incline, than any other within British dominion. The drawbacks are a want of pasturage for cattle, less open country than borders some of the more southerly passes, and an increased liability to be blocked by snow. A very large portion of the route is through forest, and some of this forest is also swamp. A road would have to be made; but it could be made without great difficulty. On the way, the country between the Red River settlement and the Rocky Mountains, is described as rich and fertile. These same Red River settlements are in a tolerably flourishing condition. The main difficulty is the want of provisions. The diggings afford good returns, but the digger must be a hunter too, and a want of a proper division of labour is felt. A great scarcity of water has been experienced, and hay has been brought from 10 to 60 miles for winter provision. The Sioux, to the number of 3,000, have at last been prevailed on to depart, much to the relief of the settlers from whom they begged their whole subsistence. The heat has been extraordinary, the thermometer having reached even 100° in the shade. The cattle have to frequent the river for drink, and even the bears do the like, appearing in the midst of the most inhabited parts, at a risk for which they pay dearly enough.

The last paper to which we can allude, was "On the New Country

of North Australia, discovered by Mr. John Macdowall Stuart." The country referred to, and which has up to this time gone simply by the name of Northern Australia, and in one part by that of Arnhem Land, has been called by Mr. Stuart, in his right as explorer and, in a sense, discoverer, Alexandra Land, in compliment to the Princess of Wales. The means of access to this district lie up the Adelaide river, which is a secure harbour at its mouth, and for 80 miles up has 40 feet of water. The land is rich and fertile, and is described as healthy for European settlers, provided Malay or Chinese workmen and labourers can be introduced in sufficient numbers to make cultivation profitable.

We would here draw the attention of discoverers to the importance of paying some attention to the nomenclature of new districts. Giving names from the members of the Royal Family, ministers, and the members of the exploring party, mark the dates of discoveries—thus Alexandra Land and Point Somerset mark the period of discovery and of settlement; but such a title as Adelaide river is apt to lead the student to the south rather than the north of Australia, whilst the scattering broadcast the name of one explorer over the whole continent, as that of some discoverers has been, is utterly bewildering, and makes the remembrance of localities, unknown to actual vision, a matter of impossibility. Thus we find in Southern Australia—Flinders county; to the north-west of this, Flinders Island; to the north-east, Flinders Lake; and again at some distance to the south-east, Flinders Black Rocks. In Queensland, we have a second Flinders County; to the south of which Flinders Peak; at some distance north again, Flinders passage; and again, to the north off Cape York (there is a Cape Yorke in South Australia), Flinders Island; and finally, an important, though yet untraced, river running into the gulf of Carpentaria, that is likely to become the means of communication between Brisbane and this northern settlement is called Flinders Creek. This is almost too much for human endurance, whatever may have been the merits of Mr. Flinders.

VII. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

Of all systematists the Geologist is the most perplexed by the occurrence of "connecting links." In organic nature gaps seem to be the rule rather than the exception, while the intervals between rock-systems are often filled up by an insignificant series of strata, partaking of the characters of both the neighbouring formations. These connecting links, or "passage-beds," between groups of rocks, are, of course, fruitful sources of discussion, some Geologists taking the view that they belong to the overlying series, others the opposite; while others again, seeing that it is perfectly hopeless to expect that either one view or the other will ever be universally accepted, adopt a

middle course, and treat them as a "distinct formation." This last appears the wisest and most practicable course, although it is often objected to because the middle term, say the objectors, is not of the same value as those on each side; but inasmuch as the whole Geological series consists of a great many terms, and it is pretty certain that their values vary almost as much as in the case in question, this objection to a rational solution ought not to outweigh the advantages accruing from its adoption.

The above paragraph may be considered to represent the state of public Geological opinion, respecting the systematic position of certain strata, known as "the Passage-beds of the Lower Lias," the "Zone of *Avicula contorta*," the "Rhætic Beds," the "Kössen Beds," the "Gervillia-beds," the "Infra-lias" (pars), the "Täbingen Beds," &c., and recently called the "Penarth Beds" by the Geological Survey.

Lately several important memoirs have been published, in which this question has been discussed at great length; their titles and authors are as follows:—"Der Jura in Franken, Schwaben, und der Schweiz." By W. Waagen. Munich, 1864.

"Der Hannoversche Jura." By Karl Von Seebach. Berlin, 1864. "Die Contorta-Zone (Zone der *Avicula contorta*, Portl.), ihre Verbreitung, und ihre organischen Einschlüsse." By Alphons von Dittmar. Munich, 1864.

"Notices Géologiques et Paléontologiques sur les Alpes Vaudoises et les Régions environnantes." By E. Renevier. Lausanne, 1864.

"Etudes sur les Etages Jurassiques inférieurs de la Normandie." By Eugène Eudes-Deslongchamps. Paris, 1864. F. Savy.

"On the Rhætic Beds and White Lias of Western and Central Somerset," &c. By W. Boyd Dawkins. 'Quarterly Journal Geological Society,' November, 1864; and 'Geological Magazine,' December, 1864.

"On the Rhætic or Penarth Beds of the Neighbourhood of Bristol and the South-west of England." By H. W. Bristow. 'Geological Magazine,' November, 1864. Read before the British Association at Bath, 1864.

The opinions expressed in these several memoirs are as various as they can be, for while Herr Waagen calls the Zone of *Avicula contorta* the uppermost member of the Keuper, M. Deslongchamps and M. Renevier consider it to belong to the Lias, the former positively, the latter more diffidently; then again, Herr von Seebach appears undecided, Mr. Boyd Dawkins* calls it the Passage-beds of the Lower Lias, and Herr Von Dittmar treats of it as a separate formation; but the last-named Geologist thinks that if it *must* be classed with one or the other formation, it should be placed with the Keuper, the balance of authority (!), he considers, favouring that view. The Geological and Palæontological evidence must indeed be conflicting, when it is found desirable to decide such a question by arbitration, and Herr von Dittmar almost proposes that this should be done. In general terms it may be said that the French and Italian Geologists consider

* We shall notice this author's paper at greater length under the head of "Proceedings of the Geological Society," p. 109.

the Zone of *Avicula contorta* to belong to the Lias, and that the German and English authorities find it more convenient to treat of it as a separate formation; but believe it to have a closer relationship with the Trias.

We have said enough to show that Geologists who have specially studied the subject are by no means agreed as to the best way of solving the difficulty; but the memoirs we have quoted all contain much valuable matter, independently of their bearing on this question. M. Renevier's paper contains a discussion on the exact meaning of the term Infra-lias, and he shows that it includes two sets of strata, which are perfectly distinct from one another in the region of the Vaudois Alps; for the lower zone he retains the name of Rhætic beds (Etage Rhétien), but for the upper he proposes that of Etage Hettangien. M. Deslongchamp's memoir is especially remarkable as containing a proposal to separate the Upper Lias of Normandy altogether from the Lias-formation, and to incorporate it with the Lower Oolite (Système Oolithique Inférieur), under the name of "Marnes Infra-Oolithiques," and in association with the Inferior Oolite, the Fullers' Earth, and the Great Oolite. This change, if adopted, would shift a battle-ground, which has hitherto been the "Upper Lias sands," or "sands of the Inferior Oolite;" but we doubt whether it will be generally accepted, and if accepted, whether matters would be improved thereby.

All the papers mentioned contain valuable lists of fossils, sections of strata, and detailed descriptions of the rocks in the several districts.

Professor Huxley's monograph "On the structure of the *Belemnitidæ*," has just been published in the Memoirs of the Geological Survey, and clears up many points in their organization that have hitherto remained more or less obscure. One magnificent specimen of a Belemnite, in the collection of the Rev. Mr. Montefiore, exhibits not only the guard, phragmacone, and pen, but also the general contour of the body, the beak, and some irregular lines of hooks indicating the position and extent of the arms. This is the most complete Belemnite ever found, and we therefore reproduce a reduced copy of the figures of it, illustrating Professor Huxley's description, especially as it gives us, with the author's aid, a clear insight into the structure and organization of the creature.

Amongst the many new points contained in this monograph, we must confine our attention almost entirely to one, namely, the systematic importance given to that rarely preserved organ which has hitherto been known as the "pen" or "osselet," but to which Professor Huxley has given the name of *pro-ostracum*, to avoid ambiguity, as he considers it to correspond to only a part of the structure known as the "pen" in recent Cephalopods. This osselet has always been a small bone of contention with naturalists, and the author, after a careful review of the works of previous writers on the subject, gives the following summary of their opinions :—

"1. According to Dr. Buckland, this part is a corneous, or shelly,

Figs. 1 and 2. *Illustrating the Structure of the genus* Belemnites.*

Fig. 1.

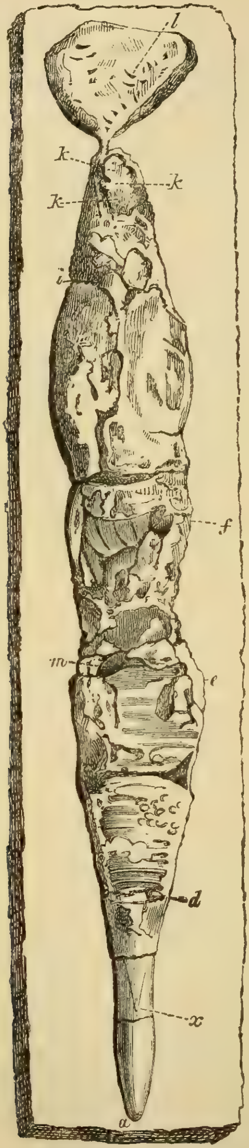

Fig. 2.

Fig. 1.—*Belemnites*, in the Rev. Mr. Montefiore's collection, showing the guard (*a* to *d*), the phragmacone (*d* to *e*), the pro-ostracum (*e* to *f*), which extended probably to *i*, the beaks (*k*), the position of the arms indicated by acetabular hooks (*l*), and the ink-bag (*m*). *x* indicates the point to which the phragmacone probably extends within the guard.

Fig. 2.—Magnified figure of two of the acetabular hooks (*see* Fig. 1 *l*).

* Reduced from Pl. I. Figs. 1, 1*a*, of Professor Huxley's monograph, by permission of the author.

and more or less completely nacreous, extension forwards of the lip of the phragmocone.

"2. According to Agassiz, it is a 'pen' identical with that of the so called *Loligo Bollensis*, &c.

"3. According to Voltz, it is a 'pen' analogous to that of *Loligo Bollensis*.

"4. According to Mantell and Quenstedt, it is a broad dorsal plate, more or less corneous in the middle, and with two strong calcified asymptotic bands."

Professor Huxley's own opinion we have already given, but the most novel portion of his views on the subject, is the belief in the systematic importance of the variations in the form of the pro-ostracum, and on this account he is disposed to favour a subdivision of the genus *Belemnites* itself, "the difference between the pro-ostraca of *B. Bruguierianus* and *B. Puzosianus* being, probably, of generic importance."

Another new point is the direct proof, furnished by the specimen we have figured, of the existence of beaks and acetabular hooks in the genus *Belemnites* (*see* Fig. 1 *l* and Fig. 2); for though they have long been known to exist in *Belemnoteuthis*, they have never before been found in *Belemnites*.

Professor Huxley also describes a new genus of *Belemnitidæ*. In 1829 Sir Henry de la Beche figured and described a remarkable specimen from the Lias of Lyme Regis under the name of *Orthocera elongata*, the true nature of which has only recently been made out by the author, from the study of a very perfect specimen not long since discovered by E. C. H. Day, Esq., F.G.S., of Charmouth. Professor Huxley describes this and the original *Orthocera* at length, and, as the newly found specimen shows that the pro-ostracum belonged to a type distinct from either of those occurring in the genus *Belemnites*, he refers the two specimens to a new genus under the name of *Xiphoteuthis elongata*; he gives a full account of its relations to other *Belemnitidæ* so far as can be ascertained from the specimens, but states that several points are still unknown or obscure.

The second part of the Philosophical Transactions for 1864 contains the following papers by Mr. Prestwich, the first two having been incorporated together under the double title:—

1. Theoretical considerations on the conditions under which the (drift) deposits containing the remains of extinct mammalia and flint implements were accumulated, and on their Geological age.

2. On the loess of the valleys of the South of England, and of the Somme and the Seine.

3. On some further evidence bearing on the excavation of the valley of the Somme by river-action, as exhibited in a section at Deucat, near Abbeville.

In these papers the author discusses the mode of formation of the beds containing flint implements, and of the river-valleys in which they occur. He first shows that the gravel-beds follow, at various levels, the course of the present valleys, and have a direction of transport coincident with that of the present rivers; but the fact of some of the

gravel-beds being so much above the existing river-channels, combined with the occurrence in them of perfect and uninjured land and fresh-water shells, and the remains (sometimes entire) of land-animals of various ages, points to a former condition of things when such levels constituted the lowest ground over which the waters passed.

Mr. Prestwich then states that there is "evidence of great transporting power" in "the size and quantity of the débris," and of "floods of extraordinary magnitude," in the fact of "fine silt, with land-shells, covering all the different gravel-beds." Thus he believes the gravel-beds were accumulated and the valleys excavated by river-action of much greater intensity than that now in operation, "periodical floods imparting a torrential character to the rivers;" moreover, he considers that "river-action peculiar to each valley commenced with the high-level gravels," and that "the mass of débris and the large blocks present in the beds indicate the action of a large volume of water, and of ice-transport."

The author also connects the loess with both series of valley-gravels and with the existing river-valleys, regarding it as contemporaneous with the associated gravel-beds, and as representing the fine silt deposited from flood waters in such parts of the channel as are in a state of comparative repose, namely, "the lee side of the hills, lateral valleys, and plains, and any local depressions or hollows," while coarser material, represented by the present gravels, was left in the more central portions. He therefore concludes that, as in the case of the associated gravels, the higher deposits of loess were formed before the excavation of the valleys, and that those on the lower terraces are of later date.

Mr. Prestwich discusses also the probable antiquity of the deposits containing the flint implements, and he shows that though, geologically, they are posterior to the boulder clay, and consequently to the great extension of the European glaciers, yet that, chronologically, measuring their age by such natural chronometers as the excavation of the river-valleys, they must be so extremely ancient that all attempts to compute their age in hundreds of thousands of years are now, and probably always will be, utterly futile.

The 'Geological Magazine' continues to sustain its excellent character, the last four numbers having contained many important original papers, and a great number of abstracts and notices of interesting British and Foreign publications As might be expected some of the original articles refer to phenomena familiar to most geological students; such, for instance, is Mr. S. P. Woodward's article "On Banded Flints," in which the author strives to show that the coloured bands have been produced by infiltration, as taught by the late Professor Henslow. On the other hand, many of the papers are of a very recondite nature, but are nevertheless readable and interesting: such are the papers by Dr. Duncan and Professor Rupert Jones "On the Miocene Beds of the West Indian Islands;" Dr. Bigsby's "Description of the Laurentian Formation," &c. Mr. S. P. Woodward's paper "On *Plicatula sigillina*" is very short, good, and exactly suited to the Magazine in which it appears; but some other papers, consisting

of mere descriptions of species, are better fitted for the "Annals and Magazine of Natural History."

Proceedings of the Geological Society.

The last two numbers of the 'Quarterly Journal' of the Geological Society contain many important papers; but we have not space to discuss more than those relating to the following subjects, which appear to be of the most general interest, namely: (1) Recent Discoveries of Flint Implements in England; (2) Welsh Lingula-flag Fossils; (3) the Mineralization of Corals; and (4) the oldest known Mammal.

1. *Recent Discoveries of Flint Implements in England.*—Since the authenticity of the flint implements of the Valley of the Somme has been admitted by competent judges, very many amateur English geologists have confined themselves to the endeavour to discover these relics of ancient man in their own districts. That success has crowned the efforts of some of them is proved by the fact that since last July the Geological Society has published accounts of further discoveries of flint implements near Bedford, by Mr. J. Wyatt, in Hampshire and in Wiltshire, by Mr. John Evans, and in Gloucestershire by Mr. E. Witchell, and these memoirs teem with the names of fortunate finders of similar weapons in the different districts treated of.

The flint implements referred to in these papers all came from freshwater gravel-beds, as is proved by the shells found in association with them; but it is remarkable, in reference to the age of the deposits, that the molluscan fauna varies very little from that now living in the neighbourhood, while the mammals, as is well known, show a very great amount of difference. It should, therefore, be recollected that changes in a mammalian fauna indicate by no means so great a lapse of time as similar changes in a molluscan fauna do, and it would appear that even Mr. Evans places almost an extreme value on the mammalian evidence in the argument which leads to the following very temperate conclusion to his paper:—"Geologically speaking, indeed, the time may appear insignificant, as compared with the vast lapse of ages represented by even a single formation; but where man is concerned, we are involuntarily led to compare the period of his duration with the short space of time embraced by history and tradition."

2. *Welsh Lingula-flag Fossils.*—Last year Mr. Salter described some fragments of a large Trilobite belonging to the genus *Paradoxides*, until then unknown in Britain, and in a more recent paper "On some new Fossils from the Lingula-flags of Wales," he has given an amended description of the great *Paradoxides* (*P. Davidis*), and has also described several new species of fossils from Porth-y-Rhaw and Solva Harbours, near St. David's, including two new genera of trilobites, and a new genus of sponges. These fossils were obtained by local observers from beds hitherto considered almost unfossiliferous, but now shown to contain a large number of species; and according to

Mr. Salter the rocks of the same localities promise to yield still further additions to the English Primordial fauna. The chief importance of these fossils is, however, their bearing on the larger question of the distinctness of the Lingula-flags (or Primordial Zone as it is called), *as a formation*, from the great Silurian "System." This is one of the many questions to which field-geologists give one answer, and palæontologists another. But while palæontologists have always a definite principle to guide them, geologists are often obliged to resort to a theory of probabilities of their own manufacture,* or to use preconceived ideas in the place of facts which nature refuses to furnish. Palæontologically, if the Primordial fauna differs much more in degree from the Llandeilo than the latter does from the Caradoc, and the Caradoc from the Lower Llandovery, and so on; or if the Primordial fauna differs from the Llandeilo in facies, or kind, while the faunæ of the other stages have the same general facies in common; then the Primordial Zone is distinct from the Silurian "System," and *vice versâ*. Mr. Salter shows that the Primordial and Llandeilo faunæ are essentially distinct, and although some shells and a cystidean are of genera common to both formations, yet the entire distinctness of the trilobitic fauna overbalances this fact, the crustacea being the surest indices of the age of Palæozoic rocks, and, we may add, the molluscan genera having generally a very wide range. Mr. Salter thus gives his conclusion respecting the distinctness of the Primordial and Silurian formations: "The intervention of the whole of the Tremadoc rocks, containing a remarkable assemblage of fossils distinct from both, easily explains the meaning of this wide difference in the fossils [alluded to above], and indicates that the epochs of the Llandeilo and Lingula-flags were separated by an enormous period of time."

3. *The Mineralization of Corals.*—The third of Dr. Duncan's important memoirs "On the Fossil Corals of the West Indian Islands," is devoted to a mineralogical description of the specimens he has already treated of palæontologically. The mode of fossilization of various organisms has long been a subject with great attractions, but of greater difficulty; and few authors who have written on the subject, have hitherto endeavoured to explain the phenomena by means of arguments and theories founded on observed facts; † but most of them have had recourse to supposititious attractions, repulsions, and mutual movements of all kinds, between equally hypothetical atoms and molecules belonging to the large group of the "infinitely little."

Dr. Duncan, however, has patiently and laboriously noted the composition, texture, colour, &c., of every specimen he has already

* Since writing this sentence we have noticed the following passage in Mr. Prestwich's last paper on Drift Deposits containing Flint Implements:—"In looking back at the subjects we have discussed, we are forcibly reminded of our dependence on the value of probabilities. On various points Geology has not at present, and probably never will have, any other means of inference. All that can be done to give weight to our argument is to multiply probabilities, and by attending to the general concordance to reduce to the minimum the chances of error."—'Phil. Trans.,' 1864, p. 298.

† Petzholdt, Leopold Von Buch, and Bischof are among those who have treated this subject philosophically.

described palæontologically, and selecting those that best illustrate the several conditions of mineralization, he has arranged them into a very good paper, forming a capital basis for future researches on the general subject of fossilization. He has also done more than this for the special subject of the West Indian fossil corals, having determined and defined the following varieties of mineralization, namely, calcareous, siliceous, siliceous and crystalline, siliceous and destructive, siliceous cast, calcareo-siliceous, calcareo-siliceous and destructive, and calcareo-siliceous cast.

One very curious result in reference to the destruction and preservation of anatomical details has been arrived at by the author, and is thus stated :—" It would appear to be a rule that the minuter structural details of corals are best preserved when the animal tissues have been well washed out by the sea, and that the loss of these details bears a relation to the length of time the decomposing soft membranes remain in contact with the sclerenchyma."

Dr. Duncan's memoir is rich in remarkable cases of silicification, each one of which might form the basis of a good paper on the theory of the subject by an experienced chemist; in this place, however, we pass them by, as well as the author's own views on specially interesting cases, but we cannot help giving his chief and most important conclusion in his own words:—" Silica, whether homogeneous, granular, or crystalline, does not appear to be deposited at first in the interspaces of corals, but replaces a salt of lime which was infiltrated partly in solution, or partly in a state of mechanical suspension in a compound fluid. The replacement does not commence until the salt of lime has acquired a certain density, and it occurs *first of all in the central parts of the loculi, in the form of granular points.*"

4. *The oldest known Mammal.*—Mr. Boyd Dawkins's paper " On the Rhætic Beds and White Lias of Western and Central Somerset, and on the Discovery of a new Fossil Mammal in the Grey Marlstones beneath the Bone-bed," is a valuable contribution to the literature of the strata treated of, and adds greatly to our knowledge of them as they occur in Somersetshire; but the chief interest of the paper is centred in the latter part, in which is described a worn premolar tooth of a new Mammal, called *Hypsiprymnopsis Rhœticus* by Mr. Dawkins, and supposed to be the oldest known representative of the Mammalia.

The tooth has an oblong crown, the summit being obliquely worn, and exhibiting on its higher side, which adheres to the stone (*see* Fig. 3), two isolated involutions of enamel on that portion of the tooth that is supported by the posterior fang. In front of these are two wider and less prominent folds, and there may have been another on the anterior corner, which has unfortunately been broken by the waves.

It will be seen from Fig. 5, that the worn premolar tooth of *Hypsiprymnus minor* exhibits a very similar appearance, the traces of the plications being no more prominent than in the fossil, although in the unworn tooth of the same species (Fig. 4) they form so marked a feature. Again, on the lower or outer side of the former, as in the

FIGS. 3—5. *Illustrating the affinities of* HYPSIPRYMNOPSIS RHÆTICUS.*

FIG. 3.

FIG. 4.

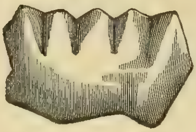

FIG. 5.

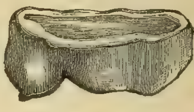

FIG. 3. Premolar of *Hypsiprymnopsis Rhæticus*, magnified four diameters.
FIG. 4. Unworn left lower premolar of *Hypsiprymnus minor*, magnified two diameters.
FIG. 5. Worn right lower premolar of *H. minor*, magnified four diameters.

fossil, there is scarcely a trace of plications, so that this character cannot well be used, Mr. Dawkins says, as an argument against the Hypsiprymnoid character of the fossil tooth.

Mr. Dawkins considers, therefore, the nearest living representative of the fossil to be *Hypsiprymnus minor*, "or some other of the kangaroo-rats with four plicated premolars;" but the fossil tooth is not more than half the size of the corresponding teeth in the recent species. The relation of *Hypsiprymnopsis* to *Microlestes* cannot be determined, because the tubercular true molars are all the remains that are known of the latter genus.

Hypsiprymnopsis Rhæticus was found by Mr. Dawkins on the sea-shore to the west of Watchet, in the hard arenaceous marlstones which yielded the first traces of life in the passage upwards from the red marls of the Trias. Its exact position was 10 feet 6 inches below the bone-bed, and therefore it is very probably, if not certainly, the oldest known trace of the Mammalia, for the Rhætic Mammalian remains hitherto found, namely, the Microlestian teeth of Frome and Diegerloch, were obtained from the bone-bed itself. The only doubtful question is, Does the bone-bed of Diegerloch represent exactly the same epoch as that of Frome and Watchet?—the English and German localities being far apart. Besides the distance of the localities, however, there is very little reason why the two bone-beds should not be contemporaneous, but there is equally little proof that they are.

* Fig. 3 was drawn from the original specimen, kindly lent for the purpose by Mr. Boyd Dawkins; Figs. 4 and 5 were copied from Figs. 4*a* and 4*b*, of Mr. Dawkin's paper in the 'Quarterly Journal' of the Geological Society, No. 80, p. 411.

VIII. MINING, MINERALOGY, AND METALLURGY.

Mining.

In every division of metalliferous mining in this country, there is a serious depression. This can be traced, in a great measure, to the disturbed condition of the American markets, which has tended to reduce the market prices of the metals. No branch of Mining has suffered so severely as the Tin Mines of Cornwall and Devonshire, and it may be safely asserted that, at the present moment, there are not ten Tin Mines in the West of England which are paying the costs of exploration. The high price of tin ore a few years since—85*l.* a ton being realized—induced adventurers to re-open many old tin mines, and to start new ones. The present price—60*l.* per ton—and even in some cases less than this, has left most of these without a chance of profit, even when the strictest economy is observed.

The system of mining which prevails in connection with our Western, and most of our Welsh Mines, is in the highest degree injurious, and by no means adapted to stand the depression which prevails at present, and which appears likely to continue.

The Mining Share Lists show that a very large number of our mines are worked by companies, divided into an unwieldy number of shares. Ten thousand shares are common; forty thousand not unusual; and fifty to seventy thousand are met with. A very large proportion of these shareholders really feel no interest in the legitimate prosecution of the mineral works, their interest being centred in the traffic in shares. The result of this is, that the mines are carelessly worked, the real business of exploration entirely neglected, and every stratagem is had recourse to for the purpose of giving a fictitious value to the shares in the market. At the present time, in even the best mines, every effort is made to produce the largest possible quantity of tin, that large apparent returns may be obtained, and dividends paid to the adventurers. Consequently, the metal market becomes overstocked, the prices of metal, and therefore of the ores from which it is obtained, still suffer a reduction, and absolute ruin must follow upon the unwise course which is being pursued.

In relation to mining for tin, we must not in our chronicles fail to record one of the most remarkable discoveries ever made in this country. The adventurers in the well-known Tin Mine, Great Huel Vor, sunk an enormous sum of money in reaching the bottom of the old mine, after it had been abandoned for more than twenty years. There was no tin in the depths of the mine, therefore all the money expended was lost. Immediately adjoining this mine, and forming, indeed, a portion of the property belonging to the company, was a small mine called Huel Metal. Attention was directed to this, and the result has been most satisfactory. The aggregate value of the different points of operation is considerably more than 1,000*l.* per fathom. "The lode at Ivey's shaft continues to improve, and is now worth between 250*l.* and 300*l.* per fathom. The 152 West of Metal

continues its value, above 200*l.* per fathom; and the 174 West has very much improved, being now worth about 50*l.* per fathom. The 184 (bottom level) is worth nearly 200*l.* per fathom. The 147 East of Ivey's, and the 147 West of Metal Shaft, are both very productive; and as these ends are within a few fathoms of each other, the important fact may be considered as established — that there is one continuous and rich body of ore from Ivey to Metal Shaft."* Such is the technical report of the managing agent. The known reserves in this mine have been estimated by a competent authority to be worth at least 200,000*l.*

The Copper Mines of Cornwall are regularly falling off in their production of ores. Indeed, nearly all the existing mines are giving indications of exhaustion. There are a few exceptional cases, for example, the production of the following mines which yielded yellow copper ore, as recorded in 1863, will be equally good in 1864:—

	Tons,		£
Devon Great Consols	26,694	value	128,576
Clifford Amalgamated	14,382	"	69,157
West Huel Seton	6,362	"	33,456
East Caradon	6,030	"	34,155
South Caradon	5,837	"	52,087
West Basset	5,387	"	31,204

Amongst the most remarkable of mining speculations which are at present engaging attention, notwithstanding the depression referred to, is the reopening of a very old and once celebrated Copper Mine, not far from Camborne, known as Crenver Huel Abraham. It is stated—and the statement may be relied on—that a contract has been taken to place this abandoned mine in working condition; that is, to clean up and open all shafts and levels, to erect machinery for pumping and winding, and to drain the mine, for 80,000*l.* In a district known as the Chiverton district, not far from Truro, upon the promise of one fortunate discovery, West Chiverton, which mine produced in 1863, 1,182 tons of lead ore, which gave also 27,269 ounces of silver, no less than fifteen mines have been started, each one involving an outlay of many thousands of pounds. Everyone who looks dispassionately at the present state of Metalliferous Mining, cannot fail to observe a most unhealthy action, which, it is to be feared, will only be remedied by the ruin of many of the ill-advised adventurers.

Twenty years since, Mr. Arthur Dean made known the existence of gold in the Quartz Rocks of Merionethshire. This gentleman has lately been appointed Consulting Engineer of the Vigra and Clogau and Welsh Mining Companies, and he has published a statement of some interest as to the production of Gold in North Wales. He writes—

"The mining territory belonging to the company is large, and the collective lengths of the principal lodes exceed 4½ miles.

"Some of these have, in former times, been extensively wrought

* 'Mining Journal.'

for copper ore, and are now found to be very auriferous; but as yet only a very small piece of one of the lodes, the St. David's, has been wrought expressly for gold. This piece has been cut off by a cross-course on the west, and is about 45 fathoms long, chiefly composed of quartz, largely impregnated with gold; the average yield of gold-bearing quartz is 10 tons per square fathom of the lode. The total amount of the lode extracted, including drivages, sinks, &c., is about 350 square fathoms, yielding 3,500 tons of mineral, good, bad, and indifferent, and of which between Jan. 12, 1861, and Sept. 3, 1864, the following quantities were crushed—

	Tons.			Oz.	dwts.	grs.
Rich picked ore, with visible gold .	39	9	yielding in gold	9,363	15	14
Poor ore, without visible gold . .	2,271	8	„	1,547	0	1
Total . . .	2,310	17				

	Oz.	dwts.	grs.	
Average yield of all the ore crushed . .	4	10	0	per ton.
„ „ the rich ore . . .	240	0	0	„
„ „ the poor ore . . .	0	13	15	„

"An experiment upon 1,036 tons of the poorest refuse from the lode, yielded $\frac{1}{4}$ oz. of gold per ton. Before St. David's lode was found to be auriferous, a large quantity of mineral, rich in gold, was extracted from it, and dressed for copper ore, and the gold was lost; but whatever the amount, it is included in the 3,500 tons extracted above mentioned.

"Worked upon a scale of (say) 50 tons per day, a yield of $\frac{1}{8}$ oz. of gold per ton will pay all costs; consequently, the lowest produce, $\frac{1}{4}$ oz. per ton, would leave half profit.

"At the Welsh Gold Company's Mines, near Tyn-y-Groes, an experiment upon one of the lodes has just been completed. A mass of $333\frac{1}{2}$ tons has been broken out and stamped, yielding $282\frac{1}{2}$ oz. of gold, or an average of 17 dwts. per ton as broken. The supply of mineral at this mine is, probably, greater than at any other gold mine in Wales, and preparations are now making to erect machinery, a large part of which is at the mines, to stamp 150 tons per day, the average yield being estimated at 10 dwts. per ton."

In connection with the subject of Gold Mining in Wales, it is right to record Dr. Crace Calvert's method of extracting gold from auriferous quartz, or from its combination with silver and copper. Finely-divided auriferous quartz should be intimately mixed with about one per cent. of peroxide of manganese, and common salt added at the same time as the manganese, in the proportion of three parts of the former to two of the latter. This mixture should be introduced into closed vats, having false bottoms with holes in them, upon which is laid a quantity of small branches covered with straw to prevent the powdered quartz from filling the holes. Diluted sulphuric acid is now added, in sufficient quantity to moisten the mass, and the whole allowed to remain in contact for twelve hours. Water should now be added so as to fill up the whole space between the false and true bottoms. This fluid should then be pumped up, and allowed to per-

colate through the mass. After this has been done several times, the fluid should be run off into separate vats, and the metals which it contains extracted. If silver is present, an excess of salt must be used in the process, for the purpose of holding in solution any chloride of silver that may have been formed.

Blades of copper placed in the saline solution precipitate the silver; then the copper is thrown down by metallic iron; and the gold is then extracted by adding to the fluid a concentrated solution of the sulphate of the protoxide of iron (green copperas), which throws down the precious metal in a metallic form.

In the Mendip Hills, mining operations on a very extensive scale were formerly prosecuted. So important was the *Myne-deeps* that a special code of laws was formed for the regulation of the mineral works upon those hills. Old slags and slimes are found spread over extensive districts, and these for some years have been turned to some small account. More important operations are just started. At the St. Cuthbert Lead Works near Wells, five new Catellan furnaces, a 30-inch cylinder steam-engine, two blast cylinders, and one of Bennett's condensers, are in process of erection. About 150 tons of good soft pig lead have been produced from this old débris within the last six months, but it is calculated that the new furnaces and blowing apparatus will yield 120 tons of pig lead a month.

The importance of the discovery of coal in our colonies cannot be overestimated. The following abstract of the Report of the official examiner, Mr. Mackenzie, of the coal-fields of the Illawarra district to the South of Sydney, is, therefore, of considerable interest. It has always been suspected that the Northern coal-field dipped under Sydney and reappeared at Wollongong. By a careful examination along the coasts of the superimposed strata, the connection of the two coal-fields has been established. The lay of the Wollongong coal-measures is traceable with tolerable clearness along the face of the sea-cliff. The top seam vanishes below the water-line at a point about thirty-four miles South of Sydney. It has been identified as reappearing above the water at Tuggerat Beach to the North of Sydney, and about seven miles South of Lake Macquarie. The Tuggerat Beach coal lies above the Lake Macquarie coal, and its identification with the Wollongong coal enables the section of the coal basin to be so far completed that the order of superposition between the Southern and Northern measures is determined. Two other outlying coal-measures are known to exist, one at Mittagong further South than Wollongong, and one above Stroud, North of Newcastle.

There are said to be twenty-six different seams of coal, averaging three feet in thickness, or containing 157 feet in thickness of coal. The strata in which these seams are imbedded represent a depth of 5,000 feet.

The Official Report concludes with the remark that these twenty-six seams do not form an exhaustive list of coal-measures, but include only those which have been so far examined as to be placed in their order. The collocation of other known seams awaits further investigation.

Near the Fitzroy Iron Mines a seam of coal thirty-eight feet in thickness has been discovered. This will, after making every allowance for waste, yield 30,000 tons an acre. At Illawarra a stratum of clay band iron-stone has been found, and shortly at Fitzroy the first Australian blast-furnace will commence operations with native material.

Amongst the Foreign mines, which greatly influence the English market, those of Chili are the most important. Recent returns of the produce of that country in the years 1861 and 1862, show the value of the minerals exported to this country—

	1861.	1862.
Cobalt ore	£17,980	£4,660
Copper ore	430,523	465,192
„ Regulus	736,290	1,211,340
„ Unwrought	275,555	204,421
„ Part wrought	228,388	302,965
Nitre, cubic	26,133	39,131
Silver ore	269,747	285,348

The following interesting notes on the new Almaden Quicksilver Mines are from the pen of B. Silliman, junior, of San Francisco:—

"The new Almaden Quicksilver Mines are situated on a range of hills subordinate to the main coast range, the highest point of which at the place is 1,200 to 1,500 feet above the valley of San José. South-west of the range which contains the quicksilver mines, the coast-range attains a considerable elevation, Mount Bache, its highest point, being over 3,800 feet in height.

"The rocks forming the range in which the quicksilver occurs are chiefly magnesian schists, sometimes calcareous and rarely argillaceous. In geological age, they are probably not older than cretaceous. There is no such thing as a well-characterized vein of ore, the quartz and its associated metals occurring rather in isolated masses or bunches segregated out of the general mass of the metamorphic rocks, and connected with each other, somewhat obscurely, by thread veins of the same mineral. The principal minerals associated with the cinnabar are quartz and calcareous spar, which usually occur together in sheets or strings, and in a majority of cases penetrate or subdivide the masses of cinnabar. Sometimes narrow threads of these minerals, accompanied by a minute coloration of cinnabar, serve as the only guide to the miner in re-discovering the metal when it has been lost in a former working.

"The main entrance to these mines, at present, is by a level about 800 feet long, and large enough to accommodate a full-sized railroad and cars. This level enters the hill about 300 feet from its summit, and is driven into a large chamber, formed by the removal of a large mass of cinnabar, leaving ample space for the hoisting and ventilating apparatus employed in working the mine. At this point a vertical shaft descends to an additional depth of nearly 300 feet, over which is placed a steam 'whim,' by means of which the ore from the various workings is conveniently discharged into the cars which convey it out of the level to the dressing-floors. In order to reach the lower work-

ings, the observer may employ the bucket as a means of descent, or he may descend by a series of ladders and steps which are placed in various large and irregular openings or cavities which have been produced by the miner in extracting the metal, these cavities are often of large proportions, measuring sometimes 150 feet × 70 feet × 40 feet in height, communicating with each other sometimes by narrow passages, and at others by arched galleries cut through the unproductive serpentine.

"Some portions of the mine are heavily timbered, while in other places columns or arches of rock are left to support the roof.

"The cinnabar occurs chiefly in two forms, a massive and a sub-crystalline. The first is fine granular, soft and easily reduced to the condition of vermilion; the other is hard, more distinctly crystalline, compact and difficult to break. It is occasionally seen veining the substance of greenish white or brown compact steatite or serpentine. The ores are extracted by contract, the miners (who are principally Mexicans, being found more adventurous than Cornishmen) receiving a price dependent upon the greater or less facility with which the ore can be broken. The price paid for the harder ores in the poorer parts of the mine is from three dollars to five dollars per cargo of 300 lbs. All the small ores and dirt hoisted from the mine are made into 'adobes,' or sun-dried bricks, for the purpose of building up the mouths of the furnaces in which the quicksilver is separated, to sustain the load of richer ores. No flux is used in these furnaces, there being sufficient lime associated with the ores to aid the decomposition of the sulphurets.

"The furnaces are built of brick, in dimensions capable of holding 60,000 to 110,000 pounds, and are fired from a lateral furnace fed with wood; connected with the furnace is a series of lofty and capacious chambers, through which all the products of combustion are passed, and all the available mercury condensed. Great care is now taken to prevent the escape of mercury through the foundations into the earth by building in the brickwork plates of iron, thereby cutting off all descending particles of the metal and turning them inward.

"Very great discoveries have recently been made at these mines. At one of the new openings a deposit of the richest description of cinnabar has been discovered, which, so far as hitherto explored, has a linear extent of at least 70 or 80 feet, and in point of richness has never been surpassed by any similar discovery in the past history of the mine.

"The process of reduction of the mercury is very simple, the time occupied from one charge to another is generally about seven days. The metal begins to run in from four to six hours after the fires are lighted, and in sixty hours the process is completed. The metal being conducted through the condensing chambers through iron pipes, which discharge into capacious kettles, after which it undergoes no further preparations for the market.

"The produce of the new Almaden Mines for the last ten years has averaged about 2,500 flasks, of 76½lbs. each, of mercury per month. The selling price at San Francisco is, at present, 75 cents per lb.,

while in London and New York it has ranged from 40 cents to 50 cents per lb."

The South Wales Institute of Mining Engineers have recently held their annual meeting, under the presidency of Mr. Alexander Bassett, of Cardiff. At this meeting, Mr. Greenwell communicated a paper on "The Copper Sands of Cheshire," and "The Alderley-Edge Copper Mines." Mr. Mather had a detailed description of "The Machinery used in Boring Artesian Wells." The President read a paper on "The Port of Cardiff, and the Aberdare Coal Fields. Besides those, were communications "On Utilizing Pit Tips," by Mr. W. Monks; "On the Nature and Manufacture of Patent Store Bricks;" and "On Re-Utilization of Slag from Blast Furnaces." Nothing can be more satisfactory than the progress made by this Institute.

We regret to record the death of the Glasgow Mining School. With every desire manifested on the part of the working miners to avail themselves of the information to be obtained in this school, it was found impossible to raise the necessary funds for its support amongst the wealthy coal owners of Scotland. This indicates a strange blindness to their own best interests; but it prevails in other mining districts than Glasgow.

Mr. Low writes us:—"With respect to the working of my patent boring machine" (described by him in detail, page 583, Vol. I. of this Journal), "it has worked most satisfactorily, together with the new air machinery, which I have constructed for working the same underground. Although the machine I have made works very well (in which provision was made for the tool to propel at three or four different speeds), yet I found a slight alteration needful, inasmuch as the progressive motion is so very varied. The alterations I am now effecting will perfect the machine, and where the three following important features will be obtained:—1st. That the tool will progress as it cuts just in proportion to the nature of the rock. 2ndly. The necessary gear and screw for propelling the tool will be done away with, and the tool will progress by the same agent as works the machine, and which will prevent the tool and piston from crystallizing (caused by the very rapid percussive blows), which affects the necessary gear and screw seriously. 3rdly. There is also a cushion of air to receive the back blows, which will also prevent the crystallizing of the working parts."

Mineralogy.

At a recent meeting of the German Association of Naturalists, M. Rose read a paper on "Meteorolites." He divided those containing iron into three classes—*meteoric irons*, *pallasites*, and *méso-sidérites*. He proposed, also, a division of meteoric stones into seven classes—*chondrites*, *hawardites*, *chassignites*, *chladnites*, *shalkites*, *charbonites*, and *eukrites*. A new mineral, discovered in a crystal by M. Rose, in a meteoric iron, was described, to which the name of *rhabdite* was given. Numerous papers, of more or less interest, were read; amongst others, one on "The Composition of Felspars," by

M. Tschermak, and one by M. Knopp "On the Tendency to Recomposition in Micas and Felspars." This last paper bears importantly upon the formation of our kaolins or porcelain clays.

M. Hautefeuille, working under the direction of M. H. Sainte Claire Deville, has communicated to the Academy of Sciences of Paris a note on "The Artificial Production of Sphéne and Pérowskite." For some years past, the laboratory of M. Sainte Claire Deville has been devoted to investigations of this class, and many of the rare productions of Nature have been reproduced, thus explaining some of the most complicated actions which interest us in the inorganic world. The artificial crystals had the following composition :—

	Sphéne.	Pérowskite.
Silica	30·9	—
Titanic acid	41·3	59·0
Lime	27·8	39·0
Loss	—	2·0

The density of the artificial *sphéne* is 3·45, that of the natural crystals 3·6. The density of the artificial pérowskite is 4·0, the natural being 4·02. At a yet more recent meeting, M. St. Claire Deville communicated the results of the continued researches of M. Hautefeuille, on the *titanates* and some *silicates*.

M. Haidinger has communicated to the Academy of Sciences of Vienna a description of a meteroic mass, which fell at Trebizonde in December last, and a note upon a specimen of native iron, recently found amongst the collections of the Museum of the University of Zurich. The meteoric character of the former appears to be, according to M. Haidinger, open to doubt; the latter specimen, which was labelled *Native Iron—very rare*, from Styria, possesses all the characteristics of genuine aërolites.

M. Daubré announces that M. Descloiseaux has discovered crystallized carbonate of soda in the meteorite of Argueil. This is the first time that alkaline carbonates have been found in bodies of meteoric origin.*

The *chladnite* of the Bishopville meteoric stone is proved to be a magnesian pyroxene, by J. Lawrence Smith, Professor of Chemistry, Medical Department, University of Louisville. In 1846, Professor C. U. Shepard published an account of this exceedingly interesting meteoric stone, that fell at Bishopville, South Carolina, in 1843, differing in its external character from other meteoric stones, the fractured mass being exceedingly white, except where metallic iron and other associate minerals occurred. The composition of the snow-white mineral (constituting about 90 per cent. of the entire mass), as given by Professor Shepard, is :—

Silica	70·41
Magnesia	28·25
Soda	1·39

From the results of this analysis, he considered it a tersilicate of

* 'L'Institut,' No. 1606.

magnesia, consituting a new species, to which he gave the name *chladnite.*

Several years after this examination, Professor Smith has obtained fragments of the meteorite, and has been able to separate the "chladnite" perfectly pure, and in sufficient quantity to submit it to a thorough analysis, the result of which shows the composition of the mineral to be—

		Oxygen Ratio.
Silica	60·12	2
Magnesia	39·45	
Peroxyde of iron	·30	1
Soda	.74	
	100·61	

Corresponding to the formula $Mg^3 Si^2$ equivalent to the general formula of pyroxene $R^3 Si^2$. The minute quantity of peroxyde of iron came from exceedingly fine particles of iron diffused through the minerals, and could be seen by a magnifying glass.

"Chladnite" approaches those forms of pyroxene known as white augite, diopside, white coccolite, &c.; these last-named minerals having a part of the magnesia replaced by lime. It is identical in composition with Enstatite of Kengott, a pyroxenic mineral from Aloysthal, in Moravia.

From these observȃtions, it will be seen, that the Bishopville meteoric stone, however different in external characteristics from other similar bodies, is, after all, identical with the great family of pyroxenic meteoric stones.*

In our last Number we recorded the discovery of *Langite*, a new mineral in Cornwall, by Mr. N. S. Maskelyne. This mineral has been analyzed by M. Pisani, who gives the following as its composition:—

Sulphuric acid	16·77
Oxide of copper	65·92
Lime	0·83
Magnesia	0·29
Water	16·19
	100·00

This gives the formula $(Cu)^4S + 4$ aq. *Langite* differs from *brochamtite*, by its containing one equivalent more of water.†

Devilline is the name given to a new mineral species from Cornwall, associated with *langite.*

This mineral is of a lighter colour than langite, and of a fibrous lamellar structure, with a milky lustre. Composition according to Pisani—

		Oxygen Ratios.
Sulphuric acid	26·65	3
Oxide of copper	51·01	
Lime	7·90	3
Protoxide of iron	2·77	
Water	16·60	3

* 'Silliman's Journal,' Sept. 1864. † 'Les Mondes,' Nov., 1864.

Giving a composition 3 R S + 3 H, where R is equal to (Cu Ca Fe), or a hydrated subsulphate of copper, of a more basic character than either langite or brochantite, having a portion of the protoxide of copper replaced by lime. That the lime is actually in combination is proved by the fact that no intermixture of gypsum could be detected by a polarizing microscope.*

Evansite is a new mineral species, which has been described by Dr. Forbes, F.R.S.

This mineral was brought from Hungary in the year 1855, by the late Mr. Brook Evans, of Birmingham, and was then reported to be found in some abundance, as an incrustation, in drusic cavities which occurred in the brown iron ores. It was regarded as pertaining to the mineral species *allophane*, with which it agrees in many of its physical properties, as hardness, colour, specific gravity, &c., as well as in percentage of loss sustained upon heating the mineral to redness.

The specimen received from Mr. Evans was labelled "Allophane, from Zsetcznik, Gomar Comitat," and was very beautiful in appearance, consisting of an agglomeration of small stalactites, with reniform and globular excrescences on brown hæmatite, many of these excrescences much resembling artificial or natural pearls, having both the figure and characteristic pearly lustre of each.

The identity of the mineral with allophane being doubted, a preliminary blow-pipe examination immediately confirmed this opinion by proving the absence of silica in any quantity, and indicating the presence of phosphoric acid; consequently, Dr. Forbes was more disposed to regard it as hydrargyllite or Gibbsite.

The physical characters of *Evansite* are as follows:—Amorphous, and without trace of crystallization; reniform or botryoidal, colourless or milk-white, and sometimes faintly tinged with yellow or blue, and occasionally presenting iridescent hues; streak white, translucent to semi-opaque. Lustre, vitreous or resinous; splendid and waxy internally; very brittle. Fracture, semi-conchoidal and shining.

Hardness 3·5 to 4; specific gravity 1·939. Analysis:—

Water	39·95
Phosphoric acid	19·05
Alumina	39·31
Insoluble (silica)	1·41
Loss	0·28
	100·00

From which the following formula may be safely deduced:—$3\ Al^2O^3$, $9\ PO^5 + 18\ HO$.†

There is a remote—and but a remote—connection between the subject we chronicle and the process of artificial petrifaction announced as discovered by Professor Efisio Marini, of Sardinia. It will be remembered by many, that a Venetian gentleman exhibited

* 'Les Mondes,' Nov., 1864. † 'Phil. Mag.' Nov., 1854.

some years since portions of the human body most thoroughly silicified, yet still retaining their natural colour. This process was lost, with the inventor of it. M. Marini, however, supposes that he has rediscovered the process of Girolamo Segato. It is stated that animal substances are petrified most readily by simple immersion in the bath of M. Marini; that they retain their colour, and are rendered absolutely indestructible. As an ingenious imitation of processes which are constantly going on in nature, and which it serves to explain, the announcement of this discovery finds a place in these pages.

M. Kuhlmann read before the Académie des Sciences of Paris, in October, the second part of his researches on "Crystallogenic Force." He applies this name to the tendency which molecules of the same nature have to form crystals. It is not a little curious to find the researches of Dana entirely ignored, and his admirable essay on Crystallogenic Force forgotten. The reader of Kuhlmann's paper would suppose that the idea of this force, as an independent energy, had originated with him, and that the name was his especial coinage, whereas the American Mineralogist has employed the term for a long period, in his large work, and has examined with great care, many of the phenomena involved in the consideration.

M. Kuhlmann's researches are of very considerable interest, and are leading, it would appear, to a solution of some of the difficulties which at present surround the laws by which crystallization, or the natural grouping of molecules into a geometric solid, is produced. The memoirs are too extensive to be reproduced, and they do not admit of condensation. The student of this interesting branch of physical science is, therefore, referred to the journals of the French Academy of Sciences.* M. Morin directed the attention of M. Kuhlmann to the spontaneous crystallization of iron—a question which still requires a close and searching examination. In connection with this, it may be noted that Mr. Paget, C.E., in May last, before the Society of Arts, and lately a correspondent to the 'Engineer,' has pointed out that wrought iron is rendered more or less brittle by strains in excess of the limits of elasticity; that a crystalline fracture is produced by any sudden rupture; that a state of brittleness, whether due to defective manufacture or to excessive strains, would render a bar peculiarly liable to rupture under impulsive forces; that rupture under such circumstances must be sudden, and, consequently, crystalline in appearance.

At a more recent meeting of the Académie des Sciencs, M. Kuhlmann exhibited a great many reproductions—by photography, electrometallurgy, and nature printing—of crystallizations upon glass plates, and which he calls crystalline tablets. This is an especially interesting mode of obtaining and preserving the forms of crystals for study.†

* 'Les Comptes Rendus.' 'L'Institut,' No. 1606. 'Les Mondes, Revue Hebdomadaire des Sciences,' Oct. 6 and 20, 1864.

† 'L'Institut,' No. 1607.

Metallurgy.

At the meeting of the Académie des Sciences of Paris, on the 7th November, M. Pelouze, in the name of M. Leguer, presented a note relative to the effects of Wolfram upon Charcoal Iron. It would appear from this note that the addition of but a very small quantity of either wolfram or tungsten increased the tenacity of the iron, and its resistance to fracture.

M. Margueritte, who has devoted considerable attention to the manufacture of steel by cementation, has combated the views of M. Caron, who inclines to the idea that combinations of carbon with nitrogen (cyanides) were necessary to the production of steel; that, in fact, steel could not be made unless nitrogen, in some state of combination, was present. His words are—"Toutes les fois qu'on cémente le fer industriellement on le met constamment en contact avec du cyanhydrate d'ammoniaque gazeux ou des cyanures volatils. Dans la pratique les cyanures seuls cémentent." This view has been entertained by several English metallurgists. The results of a very extensive series of experiments, under almost all the desired conditions, are thus expressed by M. Margueritte:—"I maintain, then, my conclusions, which are absolutely contrary to those of Mr. Saunderson and M. Caron. Mr. Saunderson has pretended that pure carbon will not convert iron into steel; and M. Caron has said—'Cyanures (cyanides) are the only agents of cementation.' I believe I have proved that pure carbon (the diamond), and also the oxide of carbon, can transform iron into steel; and that they should be counted amongst the most active and abundant elements in the processes of cementation."‡ To this M. Caron has replied by enumerating some new experiments, which lead him to the conclusion, that "Ces agents de carburation sont insignifiants dans la pratique, et s'ils méritent d'être comptés c'est parmi les *moins actifs* et les *moins utiles* de la cémentation industrielle." * So the discussion rests at present, although M. Margueritte replied to M. Caron at a more recent meeting of the Academy.

A patent has been secured for a new process, by which the surfaces of iron castings may be hardened. When a piece is filed up, or finished, it is brought to a cherry-red heat, and then immersed till quite cold in a solution composed of 1·080 grammes (of 15½ grains each) of sulphuric acid, and 65 grammes of nitric acid to 10 litres (about nine quarts) of water. The patentee informs us that the iron suffers no distortion, and that the stratum hardened is sufficient for all ordinary purposes.

In a previous page we have noticed Dr. Crace Calvert's process of treating gold ores. Mr. Beelback, of Newark, U.S., has patented an improved process for separating silver and gold from lead. He melts the lead containing these metals in a furnace with an inclined hearth, then draws it off into a kettle in which is a proper quantity of zinc to take up the silver and gold. After being well stirred together, this mixture is run into pigs or masses of a suitable size for re-melting.

* 'L'Institut,' No. 1603. † 'L'Institut,' No. 1606.

These blocks are placed on a furnace with an inclined hearth, and subjected to a low degree of heat, sufficient to cause the lead to melt and run off, but not to melt the zinc, silver, and gold.

A discovery, which promises to be an important one, has been made by M. Basset, of Paris, in the process of reducing the chlorides of aluminium. It is that the metalloids and metals which, by double decomposition, will form more fusible and more volatile compounds than the chloride of aluminium, may be employed in reducing the latter. Zinc is used in preference to any other metal. When the chloride of aluminium is brought into contact with zinc, at a temperature of from 250° to 300° *centigrade*, a chloride of zinc and free aluminium is formed. This latter will dissolve in an excess of zinc, and the chloride of zinc combining with the chloride of sodium, the mass becomes thick or pasty, and eventually solid, while the alloy of zinc and aluminium remains fluid. If the temperature of the mass is raised it again liquifies, and the zinc reduces another portion of the chloride, and the excess of zinc becomes enriched with an additional quantity of aluminium The rich alloy is then melted with the addition of more chloride of aluminium, and kept well stirred until very nearly pure aluminium is obtained. The small quantity of zinc remaining is volatilized at nearly a white heat, and pure aluminium is obtained. If this process answers upon a more extensive trial, aluminium will be produced at a much cheaper rate than hitherto, the great cost in its manufacture at present being due to the sodium employed.

Amongst the curiosities of modern metallurgy, we must regard some of the enormous castings which are made by our iron manufacturers. At the end of October, Messrs. J. M. Stanley and Co. cast two anvil blocks, each weighing 160 tons. The mould was twelve feet square at the base, and eleven feet six inches deep. This was dug out in the centre of the workshop, and from five furnaces constructed around the building the molten iron was run. The first furnace was tapped at six o'clock in the morning, and twelve hours were necessary to fill the mould. This enormous mass of iron took six weeks to cool, and it was then, by means of hydraulic power, lifted from the mould.

These anvils are intended for the gun-manufactory of Messrs. Firth and Sons, and each anvil is prepared to receive the blows of a twenty-five ton Nasmyth hammer.

Mr. Griffith's puddling machine, which we noticed in a former number, promises to produce a revolution in the puddling system. It is being adopted in several iron works. An experienced correspondent writes:—" The puddlers are treating the 'Iron man' as a friend and helper. It is not to be expected that this machine, or any other, will supersede entirely human skill and exertions. The judgment, attention, and practical skill of the puddler, will always be required; but this apparatus will lessen very much the physical toil now endured, and it more than pays for its application in the increased quantity and better quality of the work accomplished."

IX. PHYSICS.

LIGHT.—We have very few facts to chronicle this quarter in Physical Science. One of the most valuable contributions to our knowledge of the phenomena of Light has been made by Mr. Dibbitts,* who, in a paper on the Spectra of the Flames of various Gases has recorded observations made on the flame of hydrogen burnt in air, in oxygen, in nitrous and nitric oxide, and in chlorine; also of carbonic oxide and cyanogen, burnt in air, oxygen and nitrous oxide. The flames of ammonia, sulphuretted hydrogen, and of some other gases have been also examined under various conditions, the whole forming a most valuable contribution to our knowledge of the subject. A curious fact discovered by the author is, that a solution of sulphate of quinine does *not* fluoresce with the light of the flame from hydrogen, hydrocarbons, and ammonia, but does with the flame of carbonic oxide, cyanogen, sulphur, and indeed all sulphur compounds. When fluorescence does take place, it is always stronger with the flame in oxygen.

It is well known that Santonine is coloured yellow by exposure to solar light, and this takes place in a vacuum as well as in air. It does not take place, however, when the actinic rays are cut off by means of a solution of nitrate of uranium. This phenomenon has been examined by M. Sestini,† who finds that Santonine when exposed to solar light is changed into formic acid, and an uncrystallizable substance much more soluble in alcohol and ether than santonine itself, and also a rod resinous substance. To the yellow uncrystallizable substance the author has given the name of *photo-santonic acid*.

Some living specimens of the *Cucuyos*, or fire-flies (*Elater noctilucus*), coleopterous insects, very common in Mexico, have lately been brought to Paris, where they have created quite a *furore*, not only amongst the Parisian belles, who are anxious to put them to the same use as the Mexican ladies, but also amongst scientific men. They were exhibited at the Academy of Sciences, at their sitting on the 19th of September, where M. Pasteur read a paper on the properties of their phosphorescent light. The light emitted by these insects is so intense that one will enable a person to read in the dark at a short distance from the animal. Mexican ladies ornament themselves for evening parties with the insects, keeping them for the purpose, feeding them on sugar, and giving them a bath once or twice a day. The light examined by the spectroscope gives merely a continuous spectrum, very beautiful, but without lines. The author made the same observation with the light of glowworms. As it seems possible to preserve these creatures for a considerable length of time, and as Mexico is now in constant communication with Paris, some enterprising artificial florist will, no doubt, import them regularly next season.

Some valuable improvements in the production of light from gas have recently been brought forward by the Rev. W. R. Bowditch.‡

* 'Poggendorff's Annalen,' August, 1864.

† 'Bulletin de la Société Chimique de Paris,' 1864, p. 21.

‡ 'Chemical News,' vol. x. pp, 192, 216.

The principle of carburetting coal gas has already been adopted in other cases, but this method differs from all others hitherto in use by the inventor employing naphthaline, and the heaviest hydro-carbons, as the carburetting agents. These are placed in a gas-tight metallic box, into which are soldered two gas-pipes, one for conveying gas into the box, and the other for conveying gas and vapour out of the box into the burner. The burner is fixed to the outlet pipe, and is so placed that when gas is being burnt, the hot air from the gas flame must impinge upon the box. This box is provided with a screw-plug through which the hydro-carbon is put in, and this plug is closed during use. The box being supplied with hydro-carbon, or *carboline*, as the inventor styles the materials employed, is connected with any ordinary gas-fitting, and the gas is lighted. At first the gas passes over the surface of the hydro-carbon without being affected, but when the temperature has risen sufficiently to convert the hydro-carbon into vapour, the passing gas carries with it a quantity of this vapour, and the flame becomes highly illuminating, the illumination being proportional to the quantity of vapour present in the flame. As may be imagined, the increase of light is enormous, as will be seen from the following statement :—In London 1,000 feet of gas, costing 4*s*. 6*d*., give the light of 1,500 candles, when burnt in flat flame-burners. An addition to this of 4½ lbs. of carboline, costing about 9*d*., raises its light to that of 7,500 candles. The apparatus is perfectly safe, and gives no trouble. In some experiments made and verified by one of our staff, it was proved that the light given by gas passing through the carburetter at the rate of three feet per hour, was eight times greater than the light given by ordinary gas burnt under precisely similar conditions, at the rate of three-and-a-half feet per hour.

Some curious effects of the action of light upon some copper salts have been noticed by M. Rénault. When copper is plunged into any liquid capable of abandoning chlorine more or less easily, it becomes covered with a greyish white coating consisting of protochloride of copper. This salt is remarkable for the facility with which it alters when exposed to sunlight; its greyish white colour gradually deepens to black, and assumes a coppery metallic appearance. A photographic negative placed on a copper plate rendered sensitive in this manner gives a remarkably fine positive; and when the coating of chloride is sufficiently thin, the redness of the copper seen through the transparent light parts gives a more agreeable tone than is possessed by the old daguerreotype pictures. If the dry white crystalline protochloride is spread on paper, and exposed to the sun, no alteration takes place so long as the dry condition is maintained ; but on the addition of a few drops of water, each portion of the moistened protochloride paper assumes successively yellow, grey, black, and violet tints. The analogy between the properties of chlorine, bromine, iodine, fluorine, and cyanogen, led M. Rénault to investigate whether analogous photographic compounds might not be furnished with those bodies. He has accordingly obtained photographs with bromide, iodide, and fluoride of copper, the bromide being considerably more sensitive than either of the other compounds. In the early days of the daguerreotype

process it was frequently remarked that polished copper-plates iodized in a similar manner to silver ones, were also sensitive to light.

In a paper on the crystallogenic force, M. Kuhlmann has applied photography to the reproduction of some phenomena of crystallization. He coats glass with a solution of sulphate of magnesia thickened with gum, after the plan adopted by barbers and others, who ornament their windows in this way. The prettiest effects are obtained with a solution of sulphate of zinc, and the appearance may be improved by painting over the crystallization with an alcoholic solution of some colouring matter, such as fuchsine. In order to perpetuate these appearances, M. Kuhlmann has thought of copying them by photography. With Mr. Bingham's assistance, he obtained some beautiful pictures on collodion plates, and also copied the crystallizations directly on paper. The galvano-plastic method of reproducing these crystalline forms, so as to be able to print them upon paper or fabrics, was also tried. For this purpose the crystallization was obtained upon a thin plate of copper, and it was copied by putting this plate on another through a powerful rolling machine. The forms were beautifully preserved, notwithstanding the great pressure, and the plates could be used for printing, as soon as they came from the rollers. The designs may also be copied by pressing gutta-percha on glass plates covered with the crystals; the gutta-percha moulds may then be copied by the electrotype process. It was suggested that this style of ornamentation might be substituted for ordinary chasing on articles of gold and silver, and a specimen so ornamented was exhibited to the Academy. The author pointed out that no two crystallizations are obtained exactly alike. They can only be copied by photography, for the fineness of the designs would defy the *burin* of the most clever engraver; he therefore suggests that the designs would be useful for bank-notes. Copper-plates might be obtained in the way described, and if the design were printed in pale blue ink, on a bright yellow ground, the photographer and the engraver would both be defeated in obtaining a counterfeit.

A very excellent substitute for yellow glass, for the purpose of excluding the chemical rays of light, has been suggested by Mr. W. Sydney Gibbons, of Melbourne. He dissolves gelatine and bichromate of potash together, and with the hot solution coats slender fabrics. It leaves no pinholes, gives a clear orange tint, is perfectly weatherproof, and is so firm, that it admits of the use of a slight fabric, which does not itself obstruct the light. Mixed with lampblack the mixture makes a good and lasting pigment, which is admirably suited for a black board, as it stands any amount of washing after it has been actinized. The gelatine and bichromate of potash mixture, either with or without pigments, is a good material for coating bottles of substances which require darkness, as the copper solution for sugar testing, chlorine water, nitrate of silver solution, &c., the bottle only requiring to be dipped in a moderately strong warm solution.

A new binocular microscope is spoken of as having been invented in America, which is said, in 'Silliman's Journal,' to be in "every way superior to Mr. Wenham's ingenious arrangement." The inventor

of this instrument, which will set microscopists wondering, is Mr. Tolles, of Canistota, New York, long favourably known by the great excellence of his objects for the microscope and telescope, who, it is said, has advanced one step farther than Mr. Wenham. The writer of the notice by no means wishes to depreciate Mr. Wenham's invention, so freely made public, and undoubtedly the best hitherto devised; but with the new binocular eye-piece, and an objective of two-thirds, there was a marked difference in the definition by reflected and direct vision. The division of the pencil is effected so far from the objective, that the interference with definition is a minimum. The tubes are symmetrical and *parallel*, and are adjusted for different eyes by a screw and milled head, giving a range much greater than can ever be required; and no alteration is required for the adaptation of the eye-piece to any microscope, as it is used in precisely the same manner as the ordinary eye-piece. It lengthens the microscope, however, about four inches, though not necessarily so much. The eye-piece, with its present arrangement, is a first-class erecting one, giving with the various powers, up to four-tenths, full and clear fields, beautifully illuminated by the mirror alone, and without any special trouble with the higher powers, as is the case with Mr. Wenham's arrangement. The writer speaks rapturously of the appearance presented under the new eye-piece by such objects as Aulacodiscus Petersii, transparent injections, living Diatoms and Desmids, &c., but he declares that he is not at liberty at present to explain the principle upon which Mr. Tolles has been enabled to divide the pencil so far from the objective, but he declares it to be theoretically, as well as practically, correct, though it is so simple that he wonders that it did not at once occur to those eminent European opticians, who have devoted so much time and skill to the perfection of the binocular arrangement. The eye-piece works well when applied to the telescope, but the stereoscopic effect is not equal to that produced when applied to the microscope, owing to the small angle of the object-glass.

Mr. Chadburn, optician of Liverpool, has patented a new Oxy-calcium Lantern, which throws enlarged images of opaque objects on a screen, the same as the magic-lantern projects transparent ones; so that with it ordinary prints, photographs, sketches, drawings, diagrams, &c., are delineated with all their colours. Coins, medals, relievos, &c. are shown with the same accuracy. The effect produced by exhibiting a watch face with hands moving is very striking. Coloured *cartes de visite* have all the charm of oil paintings. In this particular, the instrument will be of great service to the artist, for he will be enabled thereby to throw enlarged pictures upon his canvas to any proportion, and follow every lineament with the pencil, without having the trouble of photographic manipulation on so large a scale. The instrument is most simple in its construction and management. The light used is the oxy-hydrogen. The rays from the lime cylinder, which is placed in the centre of the box, are received upon a large concave mirror and reflected to a 9-inch condensing lens, which concentrates the light upon the object to be enlarged; and this object is placed at an angle of about 45° to allow of the object-glass (double acromatic combina-

tion) to receive the illumined picture. The axis of the objective must be perpendicular to it, and also out of the angle of reflection, the object-glass refracting the image upon the screen.

HEAT.—By far the most valuable series of memoirs relating to the science of heat, have been lately published by Professor Tyndall. It would be out of our power to give, even were we to largely exceed the space at our disposal, an abstract of these important researches. We may, however, state briefly some of the results at which this indefatigable experimentalist has arrived. The researches have been mainly directed to the obscure, extra red rays of the spectrum; and as rock salt is the only known solid transparent substance which allows all of these dark heat rays to pass through with equal facility, the research has been delayed in its earlier stages by the difficulty of getting clear pieces of this mineral of a sufficient size. This difficulty is, happily, now overcome, and Professor Tyndall has lately had made for him a complete rock-salt train of a size sufficient to permit of its being substituted for the ordinary glass train of a Duboscq's electric lamp. A double rock-salt lens placed in the camera renders the rays parallel; the parallel rays then pass through a slit, and a second rock-salt lens placed without the camera produces at an appropriate distance an image of the slit. Behind this lens is placed a rock-salt prism, and a thermo-electric pile is employed to examine the spectrum produced by the prism. With both gas and hydrogen flames the maximum of heat is obtained, when the pile is placed outside the visible spectrum, a little beyond the red end. This was to be anticipated from the experiments of Sir William and Sir John Herschel. When a spiral of platinum wire is introduced into the hydrogen flame, the radiation of heat is increased from 33° to 52° as measured by the galvanometer. The action of heat on the pile was still very sensible when it was removed away from the red end of the spectrum as far as that is from the violet, thus proving that the heat spectrum is at least as long as the light spectrum. Upon substituting for the flame a coil of platinum wire, which could be rendered incandescent by a small galvanic battery, and placing the thermo-electric pile in the position of maximum heat in the spectrum, the intensity of the current which ignited the spiral was gradually increased from darkness to a full white heat. The deflection of the galvanometer, which at the dark heat was 1°, rose to 18° at a red heat; 44·4 at a bright red heat, and at a full white heat it was 60.° It will be observed that as the *refrangibility* of these heat rays remained unaltered, their increased intensity was due to greater *amplitude* of the vibrations. Allusion has been made on a former occasion to the transparency of an optically opaque solution of iodine to the ultra-red rays. More accurate experiments have shown that with intense sources of heat this liquid loses some of its transparency. Thus, the whole of the heat rays from a dark spiral, a red-hot spiral, and a hydrogen flame pass through the black solution of iodine in bisulphide of carbon, whilst from a gas flame only 96 per cent pass, and from the electric light only 90. Dr. Tyndall has found that the actual proportion of luminous to obscure rays emitted from white-hot

platinum may be thus expressed:—dividing the radiation into 24 equal parts, one of these parts is luminous and 23 obscure. When instead of the white-hot platinum the most brilliant portion of the flame of coal gas is employed, and the radiation is divided into 25 equal parts, one of these is found to be luminous and 24 obscure, whilst if the radiation from an electrical light excited by 40 cells is supposed to be divided into 10 equal parts, one of these parts is luminous and 9 obscure.

In a solution of iodine the experimentalist has now the means of almost perfectly detaching the obscure from the luminous heat rays of any source, and Dr. Tyndall has described numerous experiments in which brown paper was set on fire, gun-cotton exploded, and plates of tin and zinc fused, by placing these substances at a certain point in the air of a perfectly dark room, where the invisible rays of the electric light were concentrated. Dr. Tyndall has recounted one bold experiment on the amount of heat rays which the human eye could bear without injury. Converging the beam from the electric lamp by a glass lens, the opaque solution of iodine was placed before his open eye, and the eye was brought into the focus of the obscure rays, the heat was immediately unbearable; but it seemed that the unpleasant effect was mainly due to the action of the obscure rays upon the eyelids and other opaque parts round the eye. He therefore cut in a card an aperture, somewhat larger than the pupil, and allowed the concentrated calorific beam to enter the eye through this aperture; the sense of heat entirely disappeared. Not only were the rays thus received upon the retina incompetent to excite vision, but the optic nerves seemed unconscious of their existence even as heat. What the consequences would have been had Dr. Tyndall permitted the luminous third of the condensed beam to enter the eye, he is not prepared to say.

Mr. Barrett, assistant in the Physical Laboratory of the Royal Institution, has applied some of Dr. Tyndall's researches to the analysis of the human breath, and with very remarkable results. The mode of analysis is founded upon the calorific absorption exerted by the carbonic acid contained in the breath. With ordinary sources of heat, carbonic acid is probably the most feeble absorbent amongst the compound gases, but Dr. Tyndall has shown that where a carbonic oxide flame is used as the source of heat, carbonic acid instantly reverses its position, and exceeds all other gases in its heat-absorbing power. By employing a small carbonic oxide flame as the source of heat, and passing pure dry air into the experimental apparatus, no absorption whatever of heat was noticed, but common air gave an absorption of 15 per cent. of the total radiation; air, deprived of its aqueous vapour, but retaining its carbonic acid, gave 13·8 per cent. absorption; whilst air deprived of its carbonic acid, but retaining its aqueous vapour, gave only 6·4 per cent. By this method very small variations in the amount of carbonic acid present can be detected, and by working with air containing known quantities of carbonic acid, it was easy to construct a scale by comparison with which the percentage of carbonic acid in human breath could be ascertained with great accuracy. A series of such analyses are given, with the corresponding amounts of carbonic

acid found in some of the same portion of breath by chemical means. The accordance is very close. The fact revealed by the numerous tables which the author has given in his paper,* leaves no doubt that this method is a more delicate test for the presence of carbonic acid, than the present chemical means. As such it will be of service in many cases where chemical analysis would fail. If a simple and ready means of making a physical analysis of breath can be devised, this new method will undoubtedly be most useful in hospitals and elsewhere.

Electricity.—We have scarcely anything to chronicle this quarter in electrical science. M. Raoult has published some researches into the Thermal Phenomena of Voltameters, and measures of the quantities of heat absorbed in electro-chemical decompositions.† His experiments, relating to sulphate of copper and acidulated water, lead to the conclusion that a voltameter introduced into the current of a battery, weakens the electro-motive force, and thus destroys in the complete current a quantity of heat which is always greater than what is required for the decomposition effected. The excess varies according to circumstances; but in every case a secondary action takes place at the electrodes, whereby a quantity of heat is imparted to the voltameter equal to the excess of heat destroyed, and finally the sum of the various calorific effects of the voltameter is equal to the heat absorbed by the decomposition which goes on within it.

A valuable process for coating metals with firmly adherent and bright layers of other metals, has been communicated by M. Weil, to the Academy of Sciences.‡ The method consists in dipping the metal to be coated in a saline solution of the metal to be deposited, rendered distinctly alkaline with potash or soda, and mixed with some organic matter, such as tartaric acid or glycerine. At the same time it is necessary, in some cases, to set up a weak voltaic current, by keeping a piece of zinc or lead in contact with the metal. In this way the author obtains a firm layer of copper on iron and steel, and procures various and beautiful effects, according to the thickness of the copper deposited. Silver, nickel, and other metals, can be applied in the same way. The process, it will be seen, is susceptible of numerous applications. A curious fact mentioned is, that a clean surface of copper may be coated with zinc, by placing the two metals in contact in a solution of caustic, potash, or soda. In the cold the deposit of zinc takes place slowly, but at 100° C. it is effected rapidly.

* 'Phil. Mag.,' August, 1864.
† 'Phil. Mag.,' Dec. 1864. Supplementary number.
‡ 'Comptes Rendus,' Nov. 7, 1864.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

(Including the Proceedings of the Zoolcgical Society.)

THE Copley Medal of the Royal Society has this year been awarded to Mr. Charles Darwin, for his important researches in Geology, Zoology, and Botanical Physiology, but we are sorry to add that his state of health would not allow of his receiving it in person; and one of the Royal Medals to Mr. J. Lockhart Clarke, F.R.S., for his researches on the intimate structure of the spinal cord and brain, and on the development of the spinal cord.

The Zoological results of the late expedition to Palestine under Mr. Tristram, consist of the collection of 130 specimens of mammals, 1,760 birds, 300 reptiles, and 100 fishes. Amongst the invertebrata the principal attention of the expedition was devoted to the terrestrial molluscs and diurnal lepidoptera, of each of which very fine series were obtained, as well as a considerable number of coleoptera and orthoptera. The species of birds new to science are but few, but many rare and little known forms are amongst them. We understand that the mammals of the collection will be named by Dr. Gray and Mr. Tomes, the reptiles by Dr. Günther, the insects by Mr. Bates, and the birds and molluscs by Mr. Tristram himself. The whole results of their investigations will ultimately be combined in a general work upon the Natural History of Palestine.

Professor de Filippi, of Turin, has lately delivered an address before that university upon the relation of man to the lower animals, adding his name to the daily increasing list of distinguished naturalists who hold opinions which correspond, more or less, with those put forward by Mr. Darwin. Without following the professor through the arguments by which he endeavours to show that "the idea of the species, like that of all the other elements of classification, is to be regarded as an arbitrary conception of the human mind, having no real existence in nature," he arrives at the result that "a physiological determination of the species is impossible, and henceforward we can only speak of systematic species, of species of convenience. What we are in the habit of denominating races or varieties are incipient species; what we call species are well-defined varieties, and especially varieties confirmed by a distant origin." With regard to the position of man in nature, even admitting, as he does, the probability of a simioid ancestry for our species, he thinks that we must not depend wholly upon the evidence to be obtained from a knowledge of the comparative anatomy of man and the apes. Man, he holds, is something more than an ape, with his legs elongated, his facial angle widened, the capacity of his cranium enlarged, and in it a few grammes more of that phosphuretted paste which is called brain. The place of man in nature must be determined not by the greater or less number of morphological characters subject to variation even within the narrow limits of the species, but by the comparison of the virtuality proper to man with that of animals. In the great advance of intellectual manifestations

displayed by all races of man when compared with even the highest apes, Filippi sees a line of demarcation between man and the lower animals, "a distinction which has rather more value than that unfortunate little *hippocampus minor* about which so much has been said,—a distinction which may be physically undeterminable, but which has more force than a whole series of sophisms." Naturalists generally, however, will not be found to follow the professor to his conclusions, when he says, "In fine, we shall not be guilty of an indiscretion if we force a little more the hand of this dispenser of honours (Zoology): let us seek boldly for the investiture of a kingdom; an internal voice tells us plainly enough that we deserve it."

The habits of the higher quadrumana, as observed in a state of nature, are too little known, and every contribution is valuable. Lieut.-Col. Tickell has contributed to the Asiatic Society some account of the Gibbon of Tennasserim (Hylobates Lar), found abundantly in the forests of that province. They ascend the hills to 3,500 feet, but not higher, and range in parties of from eight to twenty, of all ages. Their howls are heard for miles round, commencing at sunrise and becoming silent about 9 A.M., after which they are engaged in feeding on fruit, young leaves, buds and shoots, and *insects*, except for which they do not willingly come to the ground. When approached they sit close in thick tufts of foliage so as to be quite safe from the shot of the sportsman, and even if forced from their concealment, their extreme agility, swinging themselves from branch to branch with their long arms, shaking the boughs all round, and flinging themselves from prodigious heights into denser foliage, renders it extremely difficult to get a shot at them. It is, on the whole, a very gentle and peaceable animal. The female has one at a birth—two are as rare as human twins—and the young one sticks to its mother's body for about seven months. So entirely does it confine itself to its hands for locomotion about the trees, that it holds anything it may have to carry, by its feet. It drinks by scooping up the water by its long, narrow hand, thus conveying to the mouth a miserably small quantity at a time.

As exhibiting the rapid acclimatization and increase of some animals, it may be mentioned that M. Müller of Faroë, a member of the Danish Parliament, states that in 1854 or 1855, two pairs of hares were introduced into Stromoë, in Faroë, from Norway, and they have increased so rapidly that there are thousands now upon the island. One may shoot twenty in a day upon the hills, and it will be impossible to exterminate them. On the other hand, the same gentleman has several times tried to import Ptarmigan from Iceland, but hitherto without success. It appears that they cannot live more than two or three days, when captured. Eggs have proved unsuccessful also, the greater part having been sat upon.

The 'Courrier des Sciences' lately contained some curious and valuable statistics concerning the colours of the vipers caught at Fort Bourbon in Martinique. No less than 432 of these venomous snakes were killed during the year, the females being in the proportion of two to seven. Thirty-eight was the highest number of eggs

found, and nine the lowest; and it was observed that when one egg contains two young vipers, one of them is always yellow.

The latest idea that has been promulgated in connection with the cultivation of sea animals, is *turtle culture.* The artificial multiplication of the turtle, on the plan of securing the eggs and protecting the young, is advocated by M. Salles, who is connected with the French navy. To some extent turtle culture is already carried on in the Island of Ascension, so far at least as the protection of the eggs, and watching over the young, is concerned. M. Salles proposes, however, to do more—he thinks that to arrive quickly at a useful result it would be best to obtain a certain number of turtles from places where they are still abundant, and transport them to such parks or receptacles as might be established on the coast of France and Corsica, where at one time they were plentiful. Animals about to lay would be the best to secure for the proposed experiments. A vessel of sufficient dimensions should be in readiness to bring away the precious freight, and the captured animals, on arriving at their destination, should be deposited in a park chosen under the following considerations:—The formation of the sides to be an enclosure by means of an artificial barrier of moderate height, formed of stones, and perpendicular within, so as to prevent the escape of the turtles; but so constructed as to admit the sea, and at the same time allow of a large, sandy background for the deposition of the eggs, which are about the size of those laid by geese. As the turtles are herbivorous, the bottom of the park should be covered with sea-weeds and marine plants of all kinds, similar to those the animals are accustomed to find at home. A fine southern exposure ought to be chosen for the site of the park, in order to obtain as much of the sunshine as possible, heat being the one grand element in the hatching of the eggs.

Little has been done for pisciculture in this country, although so much has been said and written upon the subject; but in France the art has been revived in earnest. The moment it was ascertained that M. Rémy's discoveries in artificial spawning were capable of being carried out on the largest possible scale, that scale was at once resolved upon, and the Government of the country became responsible for its success. In Scotland, earnest endeavours have been made in the Tay, which have increased the rental at least 10 per cent.; and in Ireland, Mr. Ashworth, of the Galway fisheries, finds it as profitable and as easy to breed salmon as to rear sheep. His fisheries are a decided success, and if we except the cost of some extensive engineering operations in forming fish-passes to admit of a communication with the sea, the expense of his experiments has been trifling and the returns proportionately large. Mr. Ashworth put into his fisheries no less than a million and a half of salmon eggs in the course of two seasons.

The culture of the oyster also progresses favourably, both at home and abroad. An Act of Parliament was recently passed, enabling certain persons to take possession of a large portion of the foreshore at Herne Bay, for the purpose of breeding oysters; which Act, as might have been expected, has given great offence to those interested in ex-

isting companies. For there is already at Whitstable, close by, an opulent company of oyster breeders, who annually send a very large quantity of that favourite mollusc to Billingsgate. The fishing-ground of this company is extensive, occupying a space of 1,200 acres, and affording employment to about 2,000 persons. The operations of these dredgers approach very nearly the system of culture pursued in France, the difference being that the Whitstable men do not begin by saving the *spat*, that is, they do not breed their own oysters, but content themselves with buying brood-stock from their neighbours at Colchester and elsewhere ; and the extent of their trade may be guessed from the fact of their having paid in the course of five years 150,000*l.* for brood. This company has a fleet of boats, which is valued at 20,000*l.*, while they estimate their lying stock of oysters as being worth at least 200,000*l.* ; and the earnings of the freemen of the company have averaged about twenty-four shillings per week for the last fifteen years.

The quasi-parasitic mollusc *Stilifer*, of which one species, S. Turtoni, occurs upon our coasts, has given rise to some remarks by Mr. Jeffreys, who dredged living specimens in Shetland, upon Echini. Various views have previously been taken of the position and character of the animal, and it was at first supposed to be parasitic. This, however, has been disproved ; for, although always found upon the tegumentary system of Echinoderms, the latter never appear to be otherwise than in perfect health and vigour ; and Mr. Jeffreys supposes that the Stilifer feeds upon the excretions of the Echinoderms and not on animalcules. That there is some connection between the peculiar habitat of Stilifer (on the *upper* side of the Echinus) and its food, there can be no doubt, though there may be difficulty, in defining it. A similar case occurs in *Montacuta substriata*, which always adheres by the byssus to the *lower* side of Echinoids, or to the vertical spines near the mouth, where it probably avails itself of the currents excited by the ciliary action of the latter.

A Norwegian naturalist has recently obtained by means of the same instrument used by Captain M'Clintock and Dr. Wallich, between Cape North and Spitzbergen, living animals, from a depth of 8,400 feet, or more than a mile and a half. At that depth, where the temperature was only three-tenths of a degree Centigrade, or nearly the freezing point, were found living polypes, mussels, tunicates, annelids, and bright-coloured crustaceans. The same naturalist has found Ammonites (probably Jurassic), and leaves resembling those of the Palmetto (probably Miocene) at Spitzbergen.

Mr. C. A. Wilson, of Adelaide, a diligent Entomologist, having spent many years in investigating the insects of the colony, comes to the following conclusions with respect to the relative abundance of the various orders. Taking the Coleopterous insects (probably 5,000 in number) as represented by the number 20, the Hymenoptera would be represented by 11½, the Lepidoptera by 6½, the Diptera by 4½, the Hemiptera and Heteroptera by 2, the Orthoptera by 1, and the Neuroptera by ½. The remaining orders, Thysanoptera, Aphaniptera, &c.,

have as yet only yielded so few species (of Strepsiptera none has been found) that they are not here noticed. Of the above, the Hymenoptera are principally made up of the families Ichneumonidæ and Aphidæ—the Lepidoptera of the small moths—the Diptera, by the Muscidæ—the Homoptera, by the Cecropidæ, and the Orthoptera, by the Locustidæ. With the exception of the last, this seems much the same as in European countries.

M. Baudelot, struck with some experiments by M. Faivre, which had led the latter to suppose that the respiratory movements of insects have their origin in a special region of the nervous system, as in Mammalia, has conducted a series of experiments to test the matter, the result of which has been to prove that the metathoracic ganglion is *not* the prime mover of the respiratory motions, as was believed by Faivre. The experiments were made upon Dyticus, and the lava of Libellula, and he has proved that each abdominal ganglion supplies nerve-force, and co-operates as far as it can to the accomplishment of the respiratory action of the whole. And it is remarkable that, after the sections of the nervous cord, the isolated action of a ganglion appears to be by so much weaker when it is united to a smaller number of other ganglionic elements. When one takes into consideration the division in the rings of the body and of the abdomen of the Articulata, a division frequently so much in harmony with the nervous element—when one sees in Crustacea the breathing apparatus occupy so many varied positions, now at the level of the thorax, now of the abdomen, and see them receive nerves from so many different points—it was hardly possible to admit that insects have a special nervous centre for the functions of respiration.

Dimorphism, which has been found to occur so frequently both in animals and vegetables, has been observed in the gall insects (*Cynips*) by Mr. Walsh, who has recorded his observations before the Entomological Society of Philadelphia. Part of the gall produced males and females of *C. spongifica* (in June), while another part, of wholly similar general character, remain green till autumn, and in October and November produced another form of Cynips (*C. aciculata*), hitherto regarded as a distinct species, all the individuals of which are females, and although widely different in many characters, appears only to be a dimorphic condition of the first. These (*C. spongifica*) live only six or eight days, and Mr. Walsh suggests that the female *C. aciculata* generates galls which produce, by parthonogenesis, male *C. spongifica*, and that the females and males of the latter, coupling in June, oviposit in the same month in the young buds of the oak, eggs that remain dormant till the following spring, some of which then produce female *C. spongifica* in June, and some female *C. aciculata* in the autumn, or early in the following spring, and these last in their turn, generate male *C. spongifica* to appear in the following June. And he justifies his opinion by mentioning some of the analogies which have been observed in other hymenopterous insects.

M. de Quatrefages has communicated to the Académie des Sciences some remarks upon the geographical distribution of the Annelida, and

has indicated certain general laws which contrast strikingly with facts universally recognized in other groups. The swimming and tubicolous Annelids constitute in salt water the geographical term corresponding to the land and fresh water Lumbrici and Naïades. The marine class has representatives in all seas, and this cosmopolitism belongs not only to the large genera which best reproduce the general type, but also to the most exceptional sub-types. Hence the Annelidan Fauna does not present anything resembling zoological regions, such as have been demonstrated for most of the other classes of animals. While there is a tendency to diffusion in the genera, there is a counterbalancing tendency to restriction in the species, and none, or scarcely any of the latter, are common to two continents or hemispheres. Exceptions are probably due to marine currents, as the gulf streams, which he supposes may convey a species from the West Indian seas to the Indian Ocean. The corresponding geographical terms, therefore, must only be sought among *species*. Equality of organization is one of the most general laws of the group; it does not present the difference corresponding with the latitude which are found in the Crustacea, for example. And finally, the nature of the coast has the most influence upon the development of the Annelidan Fauna, granitic and schistose coasts being generally remarkably rich in species and individuals, while calcareous coasts are remarkably poor in both.

M. Hesse has described a remarkable apparatus in parasitic Crustacea, which he denominates the *frontal cord*, and which he supposes to be an important organ of conservation in these apparently helpless creatures. This cord is very flexible, especially in its middle part; hollow, cylindrical, and covered with a few hairs. By this cord the embryo is united with its mother, being attached by one extremity to the frontal margin of the young, and by the other to the body of the mother crustacea by a circular dilatation, and is sufficiently long and flexible to allow the young crustacea to act, to a certain extent, independently of its mother, and to apply itself to the fish, on which they live in common. These embryos, especially those attached to the *Trebiæ* and *Caligi*, which swim with tolerable rapidity, follow the evolutions of their mother, like a little boat towed along by a larger vessel; and M. Hesse is of opinion that the object of this apparatus is not the alimentation of the embryo, but to assist it while feeble and destitute of organs of adhesion, to maintain its position, and resist the action of the waves during the progression of the fish on which it is parasitic.

M. Sars has made some curious observations upon the persistence in the Scandinavian lakes of certain marine Entomostraca of the glacial epoch. Harpacticus chelifer was found in a fresh-water lake in the neighbourhood of Christiansund. In the Mjoesen lake, the largest in Norway, he discovered two species of Cythere, Mysis relicta (Lov.), and Gammarus cancelloides (Gerstfeldt); the two latter species were also found by Lovén in the Swedish lakes. In ponds of the environs of Christiania the amphipod, Pontoporeia affinis, was discovered. These species all inhabit the deepest parts of the water,

and live quite separate from the two fresh-water forms of crustacea. M. Sars considers the presence of these crustacea in the Scandinavian lakes to furnish evidence that, at the glacial epoch, the basin of the Baltic was in communication with either the Eastern or Western Arctic Ocean.

M. N. Lieberkühn, in a recent memoir upon the Spongillæ, describes some peculiar motory phenomena not heretofore observed in the Sponges. In some species the cutaneous pores are dispersed in great numbers over the whole surface of the Sponge, and usually lead into a large cavity belonging to the system of ingestion. The walls of the partitions bounding these cavities have vibratile apparatus. In others, the body is traversed in all directions by *trabeculæ* of different thicknesses, which are often supported upon the integument. Some of these are completely smooth in appearance, the strongest bearing vibratile apparatus. The pores of ingestion are not characteristic of the integument, as perfectly similar orifices are seen to originate in the membranous partitions of the interior of the body. The tubes of ejection are the seat of very peculiar movements, for he has seen the cells of the innermost layer gliding up the wall of the tube, and again descending. M. Lieberkühn has also demonstrated a fact which has only been suspected since the observations of Laurent, *viz.* the reproduction of sponges by spontaneous division. In individuals kept in vessels filled with spring-water he has seen the body contract, and emit here and there processes which soon became detached and glided over the vacant portions of the siliceous skeleton, and even upon the bottom of the vessel. This division appears only to take place in individuals which are nearly perishing, but the fragments set free continue to live, and in the course of a few weeks they have produced in their interior siliceous spicules and vibratile cilia.

That indefatigable and excellent microscopist, Dr. Beale, has been studying the structure of the sarcolemma and its relations to the muscular fibre on the one hand, and to the nerve-fibre and tracheæ on the other. This investment, as is known, is not universally found upon human striped muscle, and while the general opinion of Continental anatomists is that the nerve-fibres actually perforate the sarcolemma, and come in contact with the contractible tissue, Dr. Beale believes that this is an error arising from misinterpretation of the appearances observed. With regard to insects, the sarcolemma is seen delicately striated, arising not from the muscular striæ, but produced by the ramifications of fine branches of the tracheæ, which with nerves may be followed in considerable number to the sarcolemma. Under favourable circumstances, however, the highly elaborate arrangement of the nerve-fibres and tracheæ of the muscle may be observed. The fine trunk of the nerve, one of several terminating ones, is compound, and consists of a number of exceedingly delicate nerve-fibres, each one of these being composed of still finer fibres, which subdivides very freely, forming an elaborate network, which may be traced over every part of the sarcolemma. The arrangement of the tracheæ is equally elaborate, forming a network of extremely

minute tubes, also over every part of the sarcolemma. They frequently anastomose, and the finest branches are not to be seen by the aid of a magnifying power of 200 or 300 diameters. The delicate character of this investigation is the reason that their finest branches of nerves and tracheæ have never been observed before. The result of Dr. Beale's observations is, that the membranous sarcolemma of insect muscle is composed of very fine air-tubes and nerve-fibres imbedded in a transparent material, so incorporated with it as to form a part of its substance. This elaborate sarcolemma is developed with wonderful rapidity, the entire muscle being in some cases doubled in size in the course of two or three days.

The *use of dyes* for the examination of organic structures has been well illustrated by Dr. Beale's papers on the growth of tissues. He found that when tissues were stained with carmine, a permanent stain was acquired by certain portions only of the tissue, including those which are generally supposed not to have reached their ultimate grade of development, and excluding those which have evidently undergone a structural process. Graduated colour was thus given to tissues which probably were in a course of gradual transition into "formed matter." Iodine has long and deservedly been in repute as a test for starch and cellulose, but apart from this, it does not avail much as a dye. The compounds of aniline contain some which stain parts not coloured by carmine. Thus magenta, one of the most brilliant, has distinctive qualities, and selective staining power as great as that of carmine, and still more limited. Altogether unattracted by pure cellulose, it at once seizes those portions of "formed matter" which come under the head of "secondary layers." A dye for the structures left uncoloured by both magenta and carmine, is, however, still a desideratum. A satisfactory contrast of colour is not obtained by these two dyes; mauve, Hoffman's violet, aniline brown, picrate of aniline, and turmeric, all dye as magenta, but the purples alone approximate to the desired contrast. Aniline green produces results capricious and unsatisfactory, and the ordinary aniline blue of commerce proved under the hands of Mr. Walter Abbey, an instructive failure. The tissue came out magnificently coloured, but the colour was mechanically and partially distributed, and was entirely discharged by alcohol. The second blue effected the desired contrast, but at the expense of the carmine, instead of the magenta; and the blue substitute for carmine possessed intense and splendid colouring power, even more brilliant by artificial light than by daylight.

Mr. W. H. Griffiths describes the appearance of the so-called "contractile vesicle," in the Vorticellidæ, as somewhat differing from the received account. He attributes the appearance of contraction to the fact of the vesicle having been removed from the line of focus by the movements of the living animal, and objects therefore to the term *contractile*. With regard also to the processes from the vesicle supposed to have been observed by Lachmann, he believes that they were not branches of the vesicle, but only occasional interpositions of the cilia of the disc between the object and the microscope. If these ob-

servations are correct, this so-called *circulation* in the Vorticellidæ does not exist.

At the meeting of the German Association of Naturalists and Physicians, lately held at Giessen, Professor Schaffhausen, of Bonn, gave a lecture on Spontaneous Generation. To him spontaneous generation is the only wanting link in the chain of facts which prove the unity and unchangeability of nature. He has watched organic decomposing substances, and found they give rise to the lowest imaginable and smallest visible germs, which transform themselves into fungi and monads. All larger infusoria, he maintains, are only further stages of the development of these monads. The panspermic theory of Pasteur is to him an unproven hypothesis. And in discussing the beginning of life on the globe, he maintains that the first formation must have been capable of living on water and minerals, and that such a being is to the present day still formed spontaneously—the protococcus! A remarkable discussion was evoked by this extraordinary paper, opened by Vogt, of Geneva, with the inquiry after the circumstances under which protococci originated. Having been informed that pure water in a hermatically-sealed tube would, on standing, deposit these beings, he gained an easy victory by remarking that they must be a reign of organic beings for themselves, as capable of living on pure water, which neither plants nor animals could do. Remak, of Berlin, then said, in a somewhat depreciating manner, that it was only necessary to mention the names of Ehrenberg, Schwann, Helmholtz, &c., in order to show that spontaneous generation was an untenable hypothesis. This speaker was replied to by Vogt, who declaimed against this burking of inquiry by the quotation of authorities, and denied the panspermic theory as a fallacy. The discussion does not appear to have been carried on with that calm and philosophic soberness which should distinguish similar combats of opinion.

Proceedings of the Zoological Society.

The meetings for November transacted a considerable amount of business, in the form of papers upon subjects of Zoological interest, and often the results of observations made during travel in the past summer. Mr. Newton contributed notes on the Zoology of Spitzbergen, which he has been visiting; Mr. Flower, the results of his tour among the Museums of Holland and Belgium, in a paper on the Skeletons of Whales; and Dr. Tristram some Ornithological results of his late expedition to Palestine. He enumerated 322 species of birds as obtained in that country, of which 27 were peculiar to Palestine, and nine now described for the first time, but besides these, several others had not been before brought to England. Mr. Tristram's reptiles were remarked upon by Dr. Günther; but his most remarkable collection was the series of fishes from the Lake of Galilee, of which the greater part proved to be new to science. Amongst them were several species of the African genera Chromis and Hemichromis. Several im-

portant additions to the ever-growing collection in the Regent's Park, were announced, including a young female Chimpanzee, just received from West Africa; and it was stated that the head-keeper had returned safely from Calcutta, in July, with a valuable collection of animals, amongst which were a pair of Rhinoceroses, and several species of birds new to the collection.

Mr. Gould announced two new members of our Avi-fauna, the Emberiza pusilla of Pallas, and the continental Anthus campestris, both recently taken at Brighton. Prof. Huxley read a memoir upon the Structure of the Skull of Man, the Gorilla, the Chimpanzee, and the Orang-Outang, during the period of the first dentition, and based upon materials contained in the British Museum, the Royal College of Surgeons, and particularly upon the original specimens of Tyson's "Pigmy," in the Leeds Museum. A communication also upon the Crania and Dentition of Quadrumanous Animals, *viz.* the Lemuridæ, was made by M. St. George Mivart, also from similar sources; and from which examination he is induced to divide the Lemuridæ into four natural sub-families—the Indrisidæ, Lemurinæ, Nycticebinæ, and Galagininæ.

Dr. Gray and Dr. Sclater have also been active with communications—the latter upon new birds from India, Brazil, and Madagascar; and the former with a revision of the specimens of viverrine animals in the British Museum (which possess upwards of 80 out of the 102 species of the family known to the Zoologist), and other similar papers; also a description of the atlas and cervical vertebræ of a Right Whale, in the Sydney Museum, which appears to indicate the existence of a new form of this group, distinguished by the complete separation of the atlas from the other vertebræ, and called by Dr. Gray, Macleayius Australiensis.

SCIENCE IN BRITISH NORTH AMERICA.

The progress which Science is making in this part of the Colonial possessions of Britain is very satisfactory, and is due in a great degree to the exertions of the provincial learned societies, amongst which may be mentioned the Canadian Institute, meeting at Toronto, and publishing the 'Canadian Journal of Industry, Science, and Art;' the Natural History Society of Montreal, represented by the 'Canadian Naturalist and Geologist;' and the Nova Scotian Institute of Natural Science, which publishes its 'Transactions.' The subjects, which have received attention recently, may be arranged under the various branches of Science.

1. *Botany.*—Dr. George Lawson, of Dalhousie College, has laid before the Nova Scotian Institute a Synopsis of the Canadian Flora, embracing a list of all the flowering plants and ferns that have been observed in Canada, with their habitats and distribution, preceded by general remarks on the principal features of the Flora. In

the south-western peninsula of Canada, there is a luxuriant vegetation, largely composed of species which belong especially to the States, and including the tulip tree, the black walnut, the occidental plane, and several little Southern forms. Amongst the cultivated plants, are peaches, vines, tobacco, Indian corn, wheat, potatoes, kidney-beans, and pumpkins. The characteristic trees of Upper Canada are the beech, maples, several species of oak, ash, and birch, hickories, iron-wood, bluebark, butternut, pines, hackmatack, cedars (white and red), hemlock, balsam fir, poplars, and wild cherries. The true American flora, which is a continental one, is found best represented along the southern and south-western frontier of Canada; it decreases towards the Atlantic seaboard. There are many examples of it in Nova Scotia, but here there is a much greater preponderance of northern species than in corresponding latitudes in Canada. In Western Canada, many of the plants, common in Nova Scotia, are either entirely northern, or are confined to the great swamps, whose effect on the distribution of species is thus seen to be considerable. There are numerous examples of the Arctic or Scandinavian Flora in the northern and eastern parts of Canada, and still more in the Hudson's Bay territory. Allusion was made to the fact that there is a remarkable sameness in the plants associated with boulders in different parts of the country.

Chemistry.—Dr. E. J. Chapman, in a note read before the Canadian Institute, after referring to the discrepancies to be found in comparing various accounts of the blowpipe flame of iron wire, states that a bright green flame is given out by all the light-coloured and comparatively hard wires, whilst the soft and dark wires fuse much less readily, and cause no coloration. He found the cause to lie in the former containing a minute quantity of phosphorus. This is an important point, as iron-wire is often used in blowpipe experiments as a re-agent for phosphoric acid.

The mineral springs of Wilmot, N.S., have been analyzed by Professor How, who has given the results to the Nova Scotian Institute. These waters have obtained some reputation in the Province, and also in the United States; and are said to be remarkably efficacious in curing cutaneous eruptions. They occur in a district of the New Red Sandstone formation. One analysis gave the following results:—

Contents of the water of the smaller basin in 70,000 grains, or one imperial gallon.

	Grains.
Carbonate of lime	2·70
Carbonate of magnesia	0·37
Carbonate of iron	·14
Sulphate of lime	121·98
Sulphate of soda	8·35
Sulphate of magnesia	5·35
Chloride of potassium	1·60
Silica	0·55
Phosphoric acid	traces
Organic matter	traces
	141·04

The composition of the water in the larger basin closely resembled the other, differing only in containing more organic matter. The most noticeable feature is the large amount of sulphate of lime. In this respect the Spa spring of Windsor, Nova Scotia, is allied to those of Wilmot, as it contains 106·21 grains of sulphate of lime to the gallon. The professor remarks that analyses made on larger quantities than he had at command might reveal the presence of other ingredients.

Geology.—The last annual address to the Montreal Natural History Society, was given by Principal Dawson, president. After glancing at the scientific work of the Society, and expressing his admiration of the recently published Report of the Geological Survey of Canada, he proceeded to refer to a few points in Canadian Geology, to which the Report directs attention. The first was the discovery of fossils in the lower part of the Laurentian rocks, a discovery, he remarked, which will be "one of the brightest gems in the scientific crown of the Geological Survey of Canada." He referred to the subdivisions of the Laurentian rocks as forming a cycle of deposits similar to others found in the scale of formations. This subject deserves a more careful study as a means of settling the sequence of oscillations of land and water in connection with the succession of life. It may eventually aid in establishing more precise views of the dynamics of Geology and of the lapse of geological time.

He next referred to the supposed causes of the deposition of the boulder drift of Canada. The iceberg theory has lately been giving way before a reassertion of the doctrine that land-glaciers have been the principal agents in the distribution of the boulder-drift and in the erosions with which it was accompanied. He had been unable, however, to receive the latter theory, being convinced it was not in accordance with the facts he himself had observed in Nova Scotia and in Canada. The Report supported him in the belief that glaciers could scarcely have been the agents in the striation of Canadian rocks, the transport of boulders, or the excavation of lake-basins. Amongst the reasons for this opinion he gave the following :—

1. It is difficult to suppose a universal covering of ice in connection with a wide-spread continent in a temperate latitude. Even if these regions of North America were elevated into a table-land, its breadth would secure a sufficient summer heat to melt away the ice, except from high mountain peaks. There is no fact to support the alternative suppositions of the existence of immense mountain chains now disappeared, or an unexampled degree of cold from astronomical causes. He rejected Dr. Frankland's theory of a sea with a higher temperature, as inconsistent with the evidence of fossils, and as insufficient to account for the effects.

2. It seems physically impossible that an immense sheet of ice, such as supposed, could move over an uneven surface, striating it in directions uniform over vast areas, and often different from the present inclinations of the surface; whilst, if motionless, it could not produce striations.

3. The transport of boulders to great distances, and the lodgment

of them on hill tops, could not have been occasioned by glaciers. The supposed universal glacier could have had no cliffs from which to collect them, and it must have left them, after a transport of hundreds of miles, on points as high as their origin. Moreover, boulders are found in marine strata containing sea-shells, and these *must* have been borne by floating ice. The boulder clay contains marine Post-Pliocene shells in several places.

4. The Post-Pliocene deposits of Canada indicate a gradual elevation from a state of depression, while there is nothing but the boulder-clay to represent the previous subsidence, and nothing whatever to represent the supposed ice-period, except the scratches on the rock surfaces, which must have had the same cause as the boulder clay.

5. The land and fresh-water deposits underlying the boulder clay in various places, show that the sea at the period in question had much the temperature of the present arctic currents of the coasts, and that the land was not covered by ice.

The Report of the Survey throws light on the subject, by giving a valuable table of the striations: these are found to run in two principal directions nearly at right angles. Dr. Dawson had no hesitation in stating his belief, that the force causing one of these sets had acted in a direction from the ocean toward the interior, *against the slope of the St. Lawrence valley.* This is quite inconsistent with the glacier theory, but is eminently favourable to the idea of ocean drift, such as would be caused by a subsidence of the land—a fact proved by the Post Pliocene deposits. The facts thus ascertained account for the excavation of the American lake basins, which he compared to the pot holes cut by rivers. The other set of striations would be caused during a particular stage of elevation and depression, when the former outlet would be obstructed. He finally expressed his belief that many sea-beaches, gravel-ridges, and like margins, had been mistaken for morains.

Mr. William Gossip, Secretary to the Nova Scotian Institute, has described the rocks in the vicinity of Halifax, N.S. The report, which appears in the 'Transactions,' gives an account of the relation; between the metamorphosed stratified rocks and the intruded granites the former consist chiefly of slate and quartzite. In the Halifax peninsula there is no granite. The slaty rocks, wherever laid bare, are striated, and Mr. Gossip discusses the evidences of glacial action.

Mineralogy.—Professor How, in the same 'Transactions,' commences a series of notes on the economic mineralogy of Nova Scotia, in this part treating of the iron ores and iron manufacture of the province. The value of the provincial iron as compared with the best English, is thus shown:—

	£	s.
English pig iron (Staffordshire), average per ton -	4	0
Acadian - - - ,, ,, -	7	0
English bar iron (Staffordshire) ,, ,, -	9	0
Acadian - - - ,, ,, -	15	10

Compared with Swedish, their bars rank with the best qualities. There exist in the province three localities for Titaniferous iron ore.

Zoology.—In this branch it is satisfactory to find that our colonial friends are working earnestly towards a systematic account of the various groups of the animal kingdom, as represented in the respective provinces. It will be sufficient to mention the principal memoirs. The "Soricinæ of Nova Scotia" are described by Dr. J. Bernard Gilpin; the "Mollusca of the Bermudas," by Mr. J. M. Jones, F.L.S.; the "Butterflies of Halifax, N.S.," by Mr. Thomas Belt. Dr. Gilpin, in addition has a paper "On Introduced Species of Nova Scotia," with special reference to the breed of wild ponies, which, originally turned loose on Sable Island, have been left to themselves for 150 or 200 years. He compares them with the present wild stock now existing solely in Tartary, and he concludes that in the period mentioned these animals have returned, almost literally, to the habits of the old primal stock, never yet subdued by man.

REVIEWS.

ENTOZOA.*

The recent researches of Steenstrup, Küchenmeister, Von Siebold, and others on the Continent, and of Allen Thomson, Rainey, Busk, and the author of the present volume in this country, have thrown an interest around the study of Entozoa, which has scarcely been surpassed in any other department of zoological inquiry. Although these researches have great practical value, they excited but comparatively little interest in the medical profession, till the publication of Dr. Lankester's translation of Küchenmeister's large work on 'Human Parasites,' and Mr. Huxley's translation of Von Siebold's work on 'Parasitic Worms,' by the Old Sydenham Society. Since that time no systematic work in the English language has appeared, except Dr. W. Smith's work on 'Human Entozoa,' which is professedly an adaptation of a French work by M. Devaine. Numerous papers have, however, been published in English and foreign periodicals, and in the books on practical medicine, by Dr. Watson and Dr. Aikin; and in Mr. Hulme's translation of Moquin-Tandon's 'Medical Zoology,' brief accounts of our present knowledge of the Entozoa inhabiting the human body have appeared. Under these circumstances, it seemed very desirable that all that was known on this interesting and important branch of natural history and pathological inquiry should be brought together, and no one could have been found more competent to the task than the author of the present volume. We must also congratulate Dr. Cobbold and his publishers, that they appear not to have taken up this subject as a mere matter of business, but as a labour of love. Amongst recently-published books on natural history, we do not recollect to have seen one in which all the requirements of paper, printing, and illustration have been so carefully attended to, and we are almost inclined to be jealous that inquiries into other departments of natural history have not fallen into equally generous hands. We would especially speak of the plates and woodcuts as being all that could possibly be wished for the identification of specimens, and the illustration of the text.

Dr. Cobbold divides his work into three parts. The first is devoted to the Systematic, the second to the Special, and the third to Spurious Helminthology. In the first part our author discusses the propriety of placing the various forms of parasitic worms in the same group. There is, no doubt, sufficient diversity in their forms to justify the assigning of these worms, in a purely zoological classification, to very different groups; but we are inclined to agree with Dr. Cobbold,

* 'Entozoa: an Introduction to the Study of Helminthology, with reference more particularly to the Internal Parasites of Man.' By T. Spencer Cobbold, M.D., F.R.S. London: Groombridge & Sons.

that their community of habit and similar life-history, combined with the great practical advantage of studying them together as parasites offensive and injurious to the human body, justify their union.

The following is Dr. Cobbold's proposed scheme of classification:—

Class HELMINTHA	Sub-class I. STERELMINTHA	Ord. 1. Turbellaria	
		Ord. 2. Trematoda	
	Sub-class II. CÆLELMINTHA	Ord. 3. Nematoda	ENTOZOA.
	Sub-class III. ANENTERELMINTHA	Ord. 4. Acanthocephala	
		Ord. 5. Cestoda.	

This is a good practical classification, and by placing the Thorn-headed worms (*Acanthocephala*), and Tape-worms (*Cestoda*), in a separate sub-class, the other two sub-classes have been undoubtedly strengthened.

The propriety also of placing the Turbellarian worms—Planaria, and Nemertes, with their congeners, near to the Trematode worms, will at once be apparent to all those who have studied these comparatively neglected organisms.

After having settled the questions that may arise out of his general classification, Dr. Cobbold proceeds to illustrate each of his orders. In this part of his work he takes up some particular species, and gives an account of its anatomy, development, habits, and distribution. In the description of the Turbellaria, reference is made to the curious fact of the extensibility of the species of Nemertes. One of these, *N. Borlasii*, is said to be capable of stretching itself to fully eight times the length of the body whilst at rest, so that the animal, which is ordinarily four or five feet in length, is capable of assuming a length of forty or fifty feet. These worms are, however, not entozoa.

The second order, Trematoda, are true entozoa, and are commonly known by the name of flukes. This order is composed of five families, which are mostly characterized by the number of openings upon their flat bodies, which have given the family its name. These creatures are found in the bodies of men, mammals, birds, and fishes. Dr. Cobbold has described several species. In a recent investigation of the number of species described, he says, "I recognized 344 species of flukes, 126 of these belonging to fishes, 47 to reptiles, 108 to birds, 58 to mammals, and 5 to invertebrata." This did not include those forms which are found attached to the skin of animals, which would probably raise the number to 400 species. It is in this family that Van Beneden originally observed the curious phenomena of "nursing;" but which really consists of the offspring of the original parent being capable, at certain stages of their growth, of producing new individuals. This offspring, the larval "great-grand-children," are the previously known *Cercariæ*, which ultimately become transformed into a form similar to the first parent. Dr. Cobbold gives an interesting account of his observations on *Gyrodactylus elegans*, one of the most highly developed of the Trematodes, and which he obtained from sticklebacks, caught in the Serpentine.

The Nematode, or thread-like worms, come next. These are arranged in eight families. First among them is a group familiar

enough to the young naturalist, but hardly entozoa. These are the Anguillulidæ. Who that has examined a drop of dirty water under the microscope, has not been puzzled with the appearance of a number of twisting, twirling, eel-like bodies, which no author on the microscope condescends to describe? To this family Dr. Cobbold refers vinegar-eels and paste-eels, and says, very truly, of them, their "intimate organization and course of developement is not yet well understood." Why does not some fancy microscopist take these small fish under his especial care, and let the world have the result of his labours? They would be very interesting.

Next to these small eels come the hair-worms, the Gordiidæ. In this family the tendency of the ova to develop themselves in the body of living animals is seen. It is more or less the characteristic of the whole of the entozoa to travel, and take up their abode in various localities, now inside and now away from a living animal. In this group of animals fragmentary observations have been made, which seem to show that great variety takes place in the method of their wandering. The Oxyuridæ or true thread-worms, are the next family. They are represented by a species *Oxyuris vermicularis*, only too well known as an occupant of the human body. The fact of their "wandering" has not been well made out, though suspected by Küchenmeister and others. They are easily distinguished by their minute size from the next family, the Filaridæ, which include the whip-worm (*Trichocephalus dispar*), and the round-worm (*Ascaris lumbricoides*), so commonly found in the human intestines. Members of this family are found very generally in the intestines of the higher animals. They gradually pass into the family *Strongylidæ*. One of the best known forms of this group is *Sclerostoma Syngamus*, a worm which attacks birds, and which is known to infest poultry, producing a disease familiarly known as the "gapes." It has been found in the trachea of the turkey, domestic fowl, pheasant, partridge, stork, magpie, common woodpecker, starling, and swift. It would be found in other birds, probably, were it looked for. Other forms of this family have been found to infest the common porpoise and the narwhal. These creatures have been carefully dissected and studied by Mr. Busk, and two plates of their structure, from his pencil, illustrate the text.

The last two orders belonging to Dr. Cobbold's new sub-class Anenterelmintha, are the Acanthocephala and Cestoda. The first of these orders, called also from their peculiar structure thorn-headed worms, are found infesting almost all classes of vertebrate animals, but up to the present time none have been discovered in the human body. They are especially abundant in birds and fishes, and are found anchoring themselves in the mucous membranes of the intestines of these animals, by means of the retractile thorns, or proboscis, which they bear on their heads. Upwards of one hundred species of these worms have been described. The one which Dr. Cobbold has chosen as the type for his descriptions is the *Echinorhyncus anthuris* of Dujardin, a little worm a quarter of an inch in length, found in the intestines of the lesser water-newt (*Lissotriton punctatus*). The development of these animals has been recently observed by Leuchart

in the *Echinorhynchus proteus*, a species known to inhabit the trout. Leuchart obtained the ova of this species, and having introduced them into some water containing the water-flea (*Gammarus Pulex*), he found they were readily swallowed by these animals. In a few days the young embryoes were hatched, and found boring their way through the intestinal walls into the general cavity of the body. Here they passed through changes which required only about a week to complete their perfect development in the intestine of their ultimate host.

The Cestoda, of which the common tape-worm may be taken as the type, are the most highly-developed forms of Helminths. They embrace the various forms of cystic worms of older writers, which are now known to be but larval stages in the growth of the perfect worms. Within the last few years, the life-history of these creatures has been thoroughly well made out, both by observation and experiment. These worms pass but a short period of their existence out of the bodies of their host; but in all cases they appear in various stages of their growth to occupy at least two animals of different species. The tape-worms affecting man, dogs, and cats, have been most intimately studied. During growth, they present the following phases of development :—

1. The egg.—This is developed in the "joints," or "proglottides," as they are called, of the mature animal. These pass away from the host, and the eggs escape. In this state they pass into water, or on to soil or plants, which enter the stomach and intestines of another animal. The egg appears to be favoured in its development by the gastric juice of the animal which has swallowed, and gives rise to the next stage.

2. The six-hooked embryo.—Round in form, it has the hooks placed in such a way as to enable it to pass easily through the walls of the intestines, into the circuit of the blood, when, according to its peculiar nature, it is conveyed to the liver, the brain, or the muscles of the swallowing animal. Having obtained a resting-place, it is now developed into a cystic worm—the *Cœnurus cerebralis* of the sheep, the *Cysticercus cellulosæ* of the pig, or should it become abortive, the *hydatid* of the pathologist.

3. The cyst contains in its interior the "scolex," or "head," of the perfected worm. Should this head be now swallowed by a second animal, it seizes hold of the mucous membrane of the intestines, and in the course of a few days becomes developed into the "colonial," or tape-worm, condition, which constitutes—

4. The perfected worm, or "strobila," the perfected joints of which are the proglottides, which once more produce the eggs.

Such is the life-history of these creatures, which have been more or less clearly made out in above 200 species of them. The interest of this group of animals culminates in the fact that about ten species, either in their cystic or perfect stages, affect the human being. In their cystic stages they are more dangerous to the human being than in their perfect stage. In the former they inhabit organs, as the brain, the liver, and the kidneys, from whence they cannot be easily expelled, whereas in the latter, they occupy the free surface of the

intestine, from which, by appropriate remedies, they can be easily dislodged.

We shall not attempt to follow Dr. Cobbold into the second department of his work, in which he treats of those helminths which are peculiar to the human body. The following list of human entozoa, as the most complete hitherto published, may, however, prove of interest to many of our readers:—

TREMATODA.

Fasciola hepatica	Linnæus	Rare.
Distoma lanceolatum	Mehlis	Very rare.
D. Ophthalmobium	Diesing	One case.
D. Buskii	Lankester	One case.
D. heterophyes	Siebold	Two cases.
Bilhazia hæmatobia	Cobbold	Common in Egypt.
Tetrostoma renale	Della Chiaje	One case.
Hexathyridium pinguicula	Treutler	One case.
H. venarum	Treutler	Four cases.

NEMATODA.

Ascaris lumbricoides	Linnæus	Common.
A. mystax	Rudolphi	Rare.
Trichocephalus dispar	Rudolphi	Very common.
Filaria lentis	Diesing	Very rare.
F. trachealis	Cobbold	One case.
Trichina spiralis	Owen	Common.
Strongylus bronchialis	Cobbold	Rare.
Eustrongylus gigas	Diesing	Very rare.
Sclerostoma duodenale	Cobbold	Common.
Oxyuris vermicularis	Bremser	Very common.
Dracunculus medinensis	Cobbold	Common.
D. Loa	Cobbold	Common in Africa.

CESTODA.

Tænia solium	Linnæus	Very common.
T. mediocanellata	Küchenmeister	Common.
T. acanthonias	Weinland	One case.
T. flavopuncta	Weinland	One case.
T. nana	Von Siebold	Rare.
T. elliptica	Batsch	One case.
T. marginata	Batsch	In cystic stage rare.
T. echinococcus	Von Siebold	In cystic stage common.
Bothriocephalus latus	Brenna	Rare in England.
B. caudatus	Leuchart	One case.

We have endeavoured to indicate the comparative frequency of the occurrence of these worms in the human body. The number of single and very rare cases shows that there is much to be done by subsequent observers, and that this field of observation invites further investigation, which will be rewarded by its practical utility. We must now close our notice of Dr. Cobbold's book, by recommending it to the study of all who are engaged in the investigation of the Entozoa.

THE LAWS OF HEALTH.*

It is not because we are behindhand in England with regard to public health that so few works in our language have been devoted to the subject. In fact, there are few countries in Europe in which so large a mass of matter exists on this subject. Our sanitary activity takes date from the invasion of cholera in 1831, since which time Parliamentary inquiries have resulted in a number of Blue Books containing abundant facts on the subject of public health. Our Legislature has been by no means behindhand. A Board of Health has been established, and, although not now existing, has left a permanent institution on our Statute Books. The Nuisances Removal Act, the Local Government Act, the Metropolitan Management Act, the Vaccination Act, the Army Sanitary Commission, the Burial Board, the Children's Employment Commission, the Lodging House Act, the Bakehouse Act, the Adulteration of Food Act, and a number of other Acts and institutions are so many proofs of our sanitary activity and the regard we pay to public health. To be sure, our legislation has been rather fragmentary, but that is the character of all our legislation, and our Legislators seem to glory in the fact. But during all this time, we have had no systematic teaching of Hygiene. In every University on the Continent the subject has been considered of sufficient importance to demand teaching from a special Chair; hence, men have been trained to teach and learn the first principles of Sanitary Science, and manuals and text-books have been published for the benefit of students and the public. It was a grand move in the right direction when the Government determined to give to the ill-educated youths who were induced to enter the medical service of the army, the opportunity of studying, more especially the subjects which would demand their attention as surgeons in military service. The Medical School which was first opened at Chatham, and afterwards transferred to Netley, was made to comprise a Chair of Military Hygiene, and to this Chair Dr. Edmund Parkes was appointed. A happier selection could not have been made. Dr. Parkes is not a man to sit down quietly to enjoy a good appointment. Having now delivered several courses of lectures in his new Chair, he has given to the public in this volume the subject of his teachings. Hence, we get for the first time a comprehensive work on Public Health.

Although this volume is written from the military point of view, and is prepared especially for use in the medical service of the army, it nevertheless contains the first principles of all sanitary action, and is essentially a work on general hygiene. We shall not attempt here to criticize a work which, after attentive perusal, we regard as equal to any that have appeared either in France or Germany on this subject; and which in every department gives indications of the author's comprehension and laborious inquiries. We almost regret that the

* 'A Manual of Practical Hygiene, prepared especially for Use in the Medical Service of the Army.' By Edmund A. Parkes, M.D. London: Churchill & Sons.

author has been compelled to press his large knowledge of sanitary science into the service of the army, and that he was not induced to call it a book on general public health, as, after all, the necessities of sanitary rules for the soldier, independent of the civilian, are of very small account, and might have been comprehended in a very few pages. In fact, nearly 500 out of the 600 pages, of which the book consists, is occupied with the discussion of first principles, which apply to sailors and artisans, to merchants and beggars, as well as to soldiers. The general subject of the work is treated under the heads, Water, Air, Food, Soil, Habitation, Clothes, Climate, and Disease.

The first subject treated is water, a point of first-rate importance, no doubt, both in relation to the health of soldiers and the community at large. Yet it is a strange fact that scarcely anything has been so much neglected by the armies and cities of Europe. On this point our civilization lags immensely behind that of the ancient Romans, and their ruined aqueducts are a silent reproach to modern civilization. Much of the disease of our army in India, more especially cholera, can be traced to the utter disregard of water supply, and the same may be said with regard to the visitation of cholera in the towns and villages of Great Britain. So palpably was this the case, that London, Manchester, Liverpool, Glasgow, and other great cities, have gone to an enormous expense to obtain pure water for their inhabitants. At the same time there is great popular ignorance on this subject. Although it has been shown over and over again that the surface wells in large towns are almost always contaminated with impurities, yet these wells are had recourse to, and exist in, almost every town in the kingdom. Strange to say, these wells and pumps when attacked are almost always sure to have their medical apologists, and the knowledge of one set of medical men is made to oppose the other. At the present moment it is a great defect in our medical education, that there is no teaching on the subject of preventive medicine, and young men are turned out of our medical schools as ignorant of sanitary science, as their less instructed neighbours.

Dr. Parkes examines the whole question of water supply with great ability. He first considers the quantity necessary for men to drink in health, and gives us an approximation to the average quantity required in twenty-four hours, as half an ounce to every pound which the body weighs. Thus a man weighing 150lbs. would require 75 ounces of water in the day. This, we believe, is a good approximation. Of course the quantity will vary according to the activity of the skin in getting rid of water, which again depends on occupation, climate, and the temperature of the external air. The quantity required for all the washing and other purposes of a residence depends very much on the habits of a people. In 14 English towns of second-rate magnitude, 24 gallons a day are supplied to each inhabitant. In Manchester, 20 gallons; in Liverpool, 30 gallons; in London, 50 gallons; in New York, 300 gallons. Ancient Imperial Rome received from 300 to 340 gallons per head daily.

Dr Parkes has a capital chapter on the examination of water, so that any person with a knowledge of how to use a microscope, and the

first principles of chemistry, can easily determine what are the properties of any particular water, and whether it will be fit to drink or not. A ready way of detecting the amount of organic matter, and one that is recommended by Dr. Parkes, is by the addition of permanganate of potash. The amount of permanganate destroyed is the measure of the organic matter in the water. This is even made obvious to the eye without any weighing, where a series of waters have to be examined; the permanganate losing its beautiful pink colour when decomposed. All ready methods of detecting the composition of water are of great importance to an army on the march. It is not always that clear waters are to be trusted. The notorious pump in Broad Street, Golden Square, London, yielded water perfectly clear, and was the most popular pump in the district, yet its waters killed 500 people in the three first nights of September, 1854. The cause of this dire calamity was the communication of a broken drain from a cesspool with this well; but the water at the time it was drunk gave no signs of this contamination. After such a dreadful accident as this, in a district otherwise well supplied with water by public companies, it would have been thought that this and the other surface well-pumps would have been closed. But no, there it still stands as a memorial of the difficulty of instilling into the public mind, the necessity of obeying sanitary laws, although enforced by such awful examples as this.

From water we come to air. Dr. Parkes has treated this subject in the same comprehensive and exhaustive manner as the other. Air is more important to life than water. Impure air is a source of more disease than impure water, at the same time its dangerous effects are slower in their action. The impurities of water either produce sudden disease, or their effects pass off before the next dose is taken; but the effects of impure air are cumulative, as well as sudden and disastrous. Typhus, smallpox, scarlet fever, measles, are all born of impurity of the air, as well as scrofula, consumption, and a host of diseases connected with the existence of the state of the system in which they come on. The importance of this subject is only beginning to attract attention, and amongst the most intelligent classes there is only a glimmering consciousness that impure air may become a source of disease. In our great towns, and in the majority of our populations, no knowledge of the practical value of this question seems to exist. Masses of men, women, and children are huddled together in dwelling-houses, whilst our workshops, and shops lighted with gas, are crowded with work people, and the result is a frightful mortality. But neither the costliness of this neglect in an economical, nor its wickedness in a moral, point of view, seems to produce any impression. London, with its teeming population, thus loses thousands of lives annually, and yet is the seat of a legislation, which for weeks debates on the Schleswig Holstein question, and has a press which deplores the fratricidal war in America, but has no measures of relief for those who die for want of fresh air, nor any words of compassion for the slain innocents, and the dying men and women of their own city.

In his opening chapter on this subject, Dr. Parkes discusses the

question of the quantity of fresh air required for healthy existence. After giving the result of a variety of experiments in the quantity of carbonic acid expired, and of oxygen consumed, by a human being in twenty-four hours, he comes to the conclusion that in order to render the products of expiration and transpiration uninjurious, a human being should be supplied with 2,000 cubic feet of fresh air every hour. In order that anyone may see how far short of a proper standard of pure air they are breathing, they have only to calculate whether the room they sit, sleep, or do their business in, will allow of the egress of 2,000 cubic feet of bad air, and the ingress of the same quantity of fresh air for every person occupying them; if not, they will suffer. This is one of the great problems to be solved, in order to secure a healthy existence. One great difficulty that meets us in every direction is the necessity of warmth. We try by our feelings to measure the necessity of warmth against fresh air, and as cold is much more easily appreciated than bad air, we secure warmth at a frightful expense.

A great evil which has been recently added to our civilization, is the use of gas. Its economy, its brilliancy, has led to its use in almost every household, and there can be no doubt that its use has increased our dangers from impure air fivefold. Fortunately its use has not extended to the lowest classes, or its effects would be frightful. The cause of the deadly influence of gas is, that each gas-light consumes as much oxygen, and gives out as much carbonic acid, as five human beings. It is thus that gas has given the results of overcrowding to houses, that previous to its use were free from any such effects. Nothing but the universal adoption of a system of carrying directly out of our rooms, by some means or another, the products of the combustion of these deadly consumers of oxygen, can prevent their disastrous effects on the health of the community.

Air, however, is not alone rendered impure by the respiration of human beings and combustion, but by various effluvia. These are organic and inorganic. The organic are *living*, as microscopic plants and animals, and the poisonous molecules of contagious diseases, as typhus, typhoid, and scarlet fever; and *dead*, as the poisonous molecules given off from decomposing animal and vegetable matters. All these are treated of by Dr. Parkes, and valuable practical directions are given for the ventilation of rooms, and for the getting rid of poisons in the air.

We cannot, however, follow Dr. Parkes through the remainder of his book. The space given to the consideration of food is very large, and is, perhaps, the only part of the work in which the author has been fully anticipated by other writers. At the same time we recommend the disciples of Banting to turn to Dr. Parkes's volume if they want to see the dangers into which they are likely to fall, and the absurdity of the statement made by Mr. Banting himself, that the subject of diet was not understood, and had not been studied by medical men.

The chapter on dress is well worth attention at the present day, when our Volunteers are likely to set the fashion of how a man ought

to dress to secure health and strength. Everyone must admire Dr. Parkes for the unhesitating manner in which he denounces the absurdities of many of our articles of military clothing. Our soldiers have been everywhere, and in every direction sacrificed, from the fact that the men in command have been ignorant of the first principles of Military Hygiene. It is to be hoped that after the publication of this work we shall no more be called upon to read the sickening details of a second Military Commission, but that the authorities at the Horse Guards, animated by the noble spirit of the late Lord Herbert, will see that the best way to secure courageous and intrepid soldiers is to treat them as men having minds and bodies regulated by Divine laws, which if broken must lead to their natural punishment, disease and death.

HUMAN PHYSIOLOGY.*

The fact that so large a work as this has, in the course of a few years, reached the sixth edition, is a sufficient guarantee of the utility and value of its contents. Whilst we have several other works of equal, or nearly equal, magnitude, and going over precisely the same field of research, Dr. Carpenter's book is undoubtedly unrivalled in point of style and arrangement. Whilst less of an original observer than some other writers on Systematic Physiology, no one has more firmly grasped the great principles of Biological Science, nor shown himself more capable of conveying in thoughtful language the result of the labours of others. In every new edition also the author has kept pace with the progress of his Science, a labour of no mean order, when it is considered how rapidly the various branches of Physiological inquiry have progressed. In reading this work we cannot but feel that the author must have made it a labour of love; that higher thoughts have inspired him than either the profit or the reputation of the work; he must have felt that he had a mission to fulfil, and that was, the instructing his countrymen in the elements of a science whose principles are truly one of the keys to human happiness. It must have been with a pang of regret that he felt himself called upon to obtain the assistance of younger hands to enable him to complete his sixth edition. We do not think that it redounds to the credit of England that she has nothing with which to reward one of her most distinguished Physiologists, but a post that compels him to give up his physiological studies. It is in consequence of this want of any thing like national encouragement of the culture of the Natural Sciences, that we are obliged to yield the palm of physiological discovery to the Continent, and to see our most promising men of Science

* 'Principles of Human Physiology.' By William B. Carpenter, F.R.S., F.L.S., F.G.S. Sixth edition. Edited by Henry Power, M.B. Lond. London: John Churchill & Sons.

driven into the ranks of mere mercantile or professional pursuits, for the purpose of obtaining the means of subsistence for themselves and their families.

The present edition differs considerably from the last, both in the omission of old valuable matter, as well as in the addition of new. Thus, the chapter "On the Functions of the Cerebrum," which appeared in the two last editions, is omitted in this. To students of Psychology, this would be really a loss, much to be regretted, had we not the expression of a hope on the part of Dr. Carpenter, that he may at some future time be able to expand this outline into a Manual. We have always regarded Dr. Carpenter's work as particularly valuable from the masterly way in which he has developed the details of the structure and functions of the nervous system, and we are sure that every student of the powers and operations of the mind would rejoice to have such a manual from his hands.

The new matter in this work forms a very conspicuous feature, and is very creditable to the industry and intelligence of Dr. Power. In the chapter on Food, considerable additions have been made to the section treating of the saliva; and the recent experiments of Bernard, Adrian, and Eckard on the influence of the nervous system on this secretion have been given. The experiments of Brucke and Meisner on the gastric acid, and the results of the action of this fluid on fibrin and albumen, are introduced. New matter has also been given with regard to the action of the bile and the pancreatic juice. A considerable addition has been made to the section on absorption, and an account of the researches of Graham and others on Osmosis is given. In that portion of the work devoted to the consideration of the blood, much of the old chemical matter has been omitted, and a fuller account has been given of the structure of the blood-corpuscles, and the forms of blood-crystals as seen under the microscope. A considerable portion of the chapters on circulation and respiration has been re-written. There is a very interesting chapter by the editor, on the "Balance of the Vital Economy," in which he has gone into considerable details with regard to what may be called the debtor and creditor account of the system. In this chapter the most recent researches of Bischoff, Voit, and Ranke, have been made use of, and no one can rise from its perusal without feeling that such investigations are bringing us nearer to an explanation of the phenomena of life, which cannot fail to be of great practical value.

There are also considerable additions to the chapters on the functions of the liver, kidneys, and nervous system. The chapter on muscular tissue has been considerably enlarged, whilst the subject of generation and development has been more fully described and illustrated. In fact, everything has been done for this edition which conscientious editing could do. Nor has the publisher spared in his part. Several new woodcuts have been added, and executed in a style that enhances considerably the value of the volume to the student. For the non-medical reader we regard Dr. Carpenter's 'Principles of Physiology' as the most readable book on the subject in our language, and we should be glad if any recommendation of ours would induce

men not intending to practise the medical art to study its pages. It is a mistake to suppose that the laws of life are alone of practical interest to the medical practitioner. There is no man that has a body to preserve from disease and save from a premature death that is not interested in the study of the principles of Human Physiology.

MAN AND NATURE.*

The influence of man, whether civilized or uncivilized, on the face of nature, is a subject that has not failed to attract the attention of physical geographers; but the facts of history, though often alluded to, have not yet been collected and brought into a single volume before the publication of the present work. Judging from the useful list of references at the commencement, the author has laboured very conscientiously; and the result, although rather heavy reading, is an interesting collection of valuable records.

Man produces effects on the earth's surface, both directly and indirectly, and these effects are sometimes conservative, but for the most part destructive, tending to derange and interfere with the balance of nature. That man's influence, especially in a civilized state, is exceedingly potent, there can be no doubt; and it is shown in a very striking manner in relation to the organic world. Thus millions of wild cattle are wantonly destroyed in South America, for the sake of their hides and horns; tens of thousands of elephants, for their tusks; and thousands of ostriches, for their wing feathers. And, far above and beyond all these destructions, there is the cutting down of timber, which has been carried to so great an extent in Europe, and even in North America, as to interfere greatly with climate, and change the conditions of the atmosphere. There can be no doubt that, in South-Eastern Europe, where forests no longer remain, the once well-wooded and humid hills have been turned to ridges of hard rock, without a particle of soil. Even within the historic period, these naked rocks were, to a large extent, clothed with forests. The change that has taken place is due to the continued residence of man, and it is one of which the magnitude and importance are by no means duly considered.

The removal of woods and forests seems to be one of the first results of civilization. But the effect of this removal is rapid and cumulative, and seems generally injurious. First, the earth, deprived of its green and living clothing, radiates heat much more rapidly under a clear sky at night, and receives much more heat from the sun by day. The climate thus becomes excessive. Bleak winds sweep over the cleared surface; and when rain falls, it is rapidly carried off, instead of being long retained on the surface, and carries with it

* 'Man and Nature; or, Physical Geography as modified by Human Action.' By George P. Marsh. London: Sampson Low, Son, and Marston, 1864. 8vo. pp. 560.

some proportion of the soil and rock. After such a change, rivulets, once peaceable and regular, become torrents in winter, and dry water-courses in summer; the uplands are worn away, and the beds of water-courses and lakes raised. In the same way, channels of rivers become unnavigable, estuaries are shoaled up, and sand-bars accumulated. The earth grows less productive, soil is lost, and bare rock alone remains.

Although, no doubt, there are many exceptions to this gloomy statement, yet no one can have visited the ancient seats of civilization in Europe without recognizing its general truth. Why civilization in India, China, and Japan—probably very old—has not succeeded in effecting such important changes, is partly explained by the peculiar nature of the cultivation, which carefully produces by mechanical and artificial means the results that are obtained by nature from forests. It is probable, however, that the maximum change has long been produced in those countries.

Illustrations of the result of the removal of forests are given by Mr. Marsh in great number and variety. At the surface, this result is barrenness, such as is seen in Greece, and the Greek Islands in Asia Minor, on the Karst, and in other lower and more level portions of the Alps; and also in the Central and Southern Apennines. Another surface result is the increase in frequency and violence of river floods. Below the surface the springs are equally affected: they are more irregular when the natural covering of forest has been removed: their amount also is smaller. It is a matter of familiar observation, that whenever springs have been measured, they have been found to be diminishing in their supply. Many observations to this effect have been recorded in Europe, and some even in America. A few of these are strengthened by our knowing the counter-result when the forests have been again allowed to grow.

There is good evidence that Europe generally has undergone great changes of physical geography within the last eighteen centuries. Thus the river Seine, now variable to the extent of thirty feet, was in the fourth century a steady flowing river, free from floods. Even the deltas at the mouths of some rivers seem to have commenced only when, for some reason, forests that once covered the country were destroyed. The Dinance, now one of the most dangerous streams in Europe, owing to its constant and fierce torrents, was a navigable stream in the time of the Romans. In torrents this stream has brought down and deposited in its course, or at its mouth, much of the best soil of the Alps. The country through which it passes is being depopulated. These cases are neither isolated nor exaggerated.

The pages devoted to illustrations of this very important and much-neglected fact, are many and instructive. The authorities quoted are numerous and trustworthy, and the conclusion is unquestionably sound. Man, by his removal of forest, has done and is doing so much to modify the face of the earth, and what he is doing tends so greatly to alter climate for the worse, that it ought to be a very serious question with governments, whether the removal of forest should not be checked, and the growth encouraged. When forest

lands are cleared, and converted into fields and pastures, the gain to mankind is not so great as it might at first appear.

Among the uses of forests Mr. Marsh includes that of holding up the rocks in mountain districts, and preventing avalanches. That in certain cases they may have done this there is little doubt, although, of course, a forest would not check the descent of an avalanche once in motion.

It is not only for the sake of the timber, or for clearing land for other crops, that forests have been removed. In settled countries they are often cut down for some peculiar or local reason. As retreats of criminals, or as harbouring birds which are believed to steal fruit and grain, trees have been removed in large quantities. In Spain, a country where the effect of wood would be eminently favourable, the superstitions of the people absolutely prevent planting with any chance of success.

As, then, the destruction of forests by man has often had a great and injurious effect on climate—rendering it more extreme, and diminishing the quantity of land covered by vegetation—increasing the torrents in mountain districts, lowering and making irregular the height of water in streams, and reducing the springs over large districts—it behoves men associated under governments to keep apart a certain definite proportion of their lands for forest cultivation, and thus bring back a more favourable condition for the cultivation of the rest of the country.

The effects of human labour in reclaiming from the sea lands already covered with water, and still more in preventing those occasional incursions on border-lands which render them useless and mischievous, are too well known to need remark. Thus, on the east coast of England, half a million of acres of unhealthy marsh, pool, and tide-washed flat, have been converted into healthy arable land and pasture.

Large as this result may seem, it is little more than half that which has been recovered on the opposite shores of Holland. The works by which these great results are obtained, are exceedingly costly, and require incessant and most careful supervision. They are human in their origin, and if left alone for a few years, they would not fail to be destroyed by the constant encroachment of the sea. Whenever, also, the soil is less than four or five feet above low-water level, pumps worked by wind, water, or steam, must be employed to keep the land dry enough for use. There can be no doubt that human influence, by extending the area of low lands near the sea, and at the same time removing a large quantity of surface-water, has affected the climate in the districts where this work has been carried on on a large scale; but a still greater effect has been produced by the lowering of lakes—an operation largely executed not only in Europe but in the East. Such works, by reducing the water-surface of a country, diminish the evaporation, and also the supply to be obtained from springs and rivulets at low levels. Ordinary draining operations carried on largely in cultivated lands, cannot but produce a large result, which is, on the other hand, counterbalanced by the

effects of irrigation—a proceeding far more extensively and successfully adopted in Southern Europe, and generally around the shores of the Mediterranean basin, than persons who have not visited those countries can imagine. In Lombardy alone it is estimated by competent authorities, that every day in summer there is an amount of irrigation "diffusing over 550,000 hectares (1,360,000 acres), forty-five millions of cubic metres (about ten thousand millions of gallons) of water." As near as can be ascertained, the amount of water applied to irrigated lands is scarcely anywhere less than the total precipitation during the season of vegetable growth; and in general it much exceeds that quantity. Spain offers examples on an equally large scale.

The practice of irrigation to this extent very seriously interferes with the quantity of water that would otherwise be conveyed by rivers to the sea. Thus, in the case of the Po, the quantity of water withdrawn is estimated to be equal to the whole water-contents of the Seine, under average conditions. The works now in operation in Egypt are estimated to remove one-fifth of the whole quantity of water carried down by the Nile. The climatic result of this change is often shown in the poisonous and malarious state of the air where irrigation is prevalent. The cultivation of rice, which always requires much water, is uniformly unhealthy. There is reason to believe that the salts (chiefly sulphate of soda and common salt) sometimes now found on sterile tracts, are the results of former irrigation; and that many parts of North Africa, and of Northern and Western India, now barren, were once exceedingly rich. This remark applies especially to the valley of the Nile in Egypt and Nubia, and some parts of the great African Desert.

River dykes confining the course of a stream within definite banks, may be added to the means by which marsh lands are reduced to ordinary soil.

The drainage of the Val di Chiana, and the alterations effected in the *Maremme*, or marsh lands of Tuscany, have produced results on the physical geography of the adjacent country exceedingly remarkable and interesting. The valley of Chiana intervenes between the courses of the Arno and the Tiber; and it has been supposed, that in former times the waters of the Upper Arno may by it have flowed into the Tiber. At present, its waters connect with the Arno. The result of the engineering operations by which this has been effected, is the reclaiming of about 450 square miles of pond, marsh, and sickly swamp, and the improvement of the sanitary condition of the whole district. The natural slope has been reversed, and the water-shed removed thirty-five miles farther south, greatly increasing the Arno, and diminishing or helping to diminish the floodings of that river. On the other hand, the waters of the Tiber have been lowered.

The Tuscan *Maremme* are by no means exclusively marsh lands. The term includes much high land and even mountain peaks, one of which rises to the height of 6,280 feet. The coast, however, is low, flat, and recently formed, and malaria is prevalent to a height of nearly 1,000 feet. By a series of engineering operations, the low wet lands have been gradually filled up; and thus the mud, which would

have formed unhealthy deltas of the river, has been utilized, and now makes the coast more healthy. The quantity of sediment thus made available artificially, is estimated at not less than twelve millions of cubic yards per annum.

Among the larger phenomena of nature capable of being brought under human influence, the checking of the progress of sand-hills must be regarded as one by no means slight or unimportant. To understand the agency of man in fixing or rendering permanent long lines of dunes on an exposed coast, or in a desert subject to winds blowing persistently from some one quarter, the nature and origin of such heaps of loose material must be considered. They are not by any means always of the same nature. The particles of sand, generally siliceous and rounded, are sometimes of other rock and angular. There are sands of garnet, others of black titaniferous iron, some of fine, others of extremely coarse grains. Most of these heaps contain much water, so that by digging into them to a short depth fresh water is reached. Hence, by a systematic planting of certain grasses, their movements onwards may be checked, and in time they become consolidated. Afterwards trees grow upon them, and they undergo little further change. On the other hand, by removing the vegetable covering from some of those formerly existing on the coasts of Flanders, it is not unlikely that the dunes have once more been exposed to the attack of winds. As they often serve as barriers against the sea, it is easy to contemplate the result, should they by any carelessness be allowed to be set in motion. Very serious results of this kind have already taken place, among which may be quoted the irruption of the sea into the fresh-water lagoon of the Lijmfjord, in Jutland, in 1825. This result, which is expressly ascribed to the "mismanagement of the dunes," occasioned changes so remarkable, as to be well worthy of record, and in the highest degree instructive to the geologist. The lagoon was famous for its abundant fisheries. Millions of fresh-water fish were thrown on shore, partly dead and partly dying, and were carted off by the people. A few revived, and still frequent the shores at the mouth of the brooks. The eel has adapted itself to the change, but to the rest the salt has been fatal. It is more than probable that the sand washed in by the irruption covers in many places a layer of dead fish.

At the time of the accident, also, the bottom of the Lijmfjord was covered with a vigorous growth of aquatic plants, belonging both to fresh and salt-water, especially *Zostera marina.* This totally disappeared after the accident, and, in some instances, was buried under sand; but even where there was no sand the *Zostera*, though a marine plant, was destroyed. It is certain, that at some former period there had been a communication between the Lijmfjord and the German Ocean; so that if we could get a clean section through its bottom, we should find beds of *Ostrea edulis* and *Cardium edule*, covered up by a layer of sand, with *Zostera* and fresh-water fish; and this again covered with sand and beds of *Mytilus edulis.* If the new channel should be closed, which it might easily be, the lagoon would be converted first into brackish and then into fresh water, and there would be a further

alternation of marine and fresh-water inhabitants. In all this there are no important changes of the land surface.

The control of dunes by man is effected either by forming them originally by artificial means, by protecting them when natural, or by removing them when that can safely be done. In some places a mere artificial wall will give rise to a broad belt of dune. Thus, in 1610, a wall of three or four miles in length, thrown across a tide-washed flat between the Zuider Sea and the North Sea, occasioned the formation of rows of dunes a mile in breadth, and altogether excluded the sea. Similar results have been obtained by mere plank walls and screens of reeds. Where dunes already exist, they can be prevented from advancing by planting certain grasses, creeping plants, and shrubs, the *Arundo arenaria* being the most valuable. This plant grows to the height of about two feet; but its strong roots and their rootlets extend forty or fifty feet through the sand. The looser the soil the better it thrives, and as soon as the sand ceases to drift it dies, its roots fertilizing the sand and helping to form a vegetable mould for forest planting, pasturage, and ultimately arable land. The leaves of the *Arundo* are nutritious food for cattle and sheep; its seeds feed poultry; cordage and twine are made from its fibres; it thatches well, and its roots are good fuel. So many valuable properties sometimes check its main use as a safeguard against the drifting sands. The beach-grass is an American representative of this plant. On the French coast upwards of 100,000 acres of land have been reclaimed; and in other parts of Europe a very large area.

Of trees to succeed the *Arundo*, none is better than the *Pinus maritima*, where it will grow. Its resins yield, according to the French returns, a clear profit of 20*s.* per acre per annum, exclusively of the value of the timber.

As the plains and dunes of sand on the European coasts are estimated to amount to at least 20,000 square miles, it is evident that much yet remains for human agency in this matter; and as moving sand is invariably mischievous, while fixed sands rapidly become profitable, the subject is one of extreme practical importance.

Great public works—such as the cutting of marine isthmuses, connecting different drainages by canals, and diverting the course of rivers—are occasionally, though very rarely, effected by man; rarely, that is, considering the number of cases in which engineering operations of this nature would alter the mode of communication between distant lands.

There cannot be a doubt that the successful carrying out of the scheme for connecting the Mediterranean with the Red Sea, or that across the Isthmus of Darien, would produce physical changes of the greatest magnitude. Whether these would involve modifications of the surface, is doubtful; but so far as animal and vegetable life is concerned, they could not fail to act. Even the Great Gulf Stream itself might be induced so far to change its course by a wide channel through Central America, as to alter entirely the whole climate of Western Europe. But these are speculative and possible, rather than

known changes, and it is enough to limit ourselves to those that have actually taken place.

There are certain incidental effects produced, not by, but through and on account of, civilization and the passage of man over the earth that are worthy of notice.

A little iron, deposited under peculiar circumstances, will provide material for cementing a large extent of sand. A few street-sweepings have formed the nucleus of a considerable marine deposit. A man in Malta wishing to establish salt works on his land, which was situated over a large cave open to the sea, sunk a well into the cave to draw up the sea-water for evaporation. This opening once made, the sea took advantage of it. During heavy gales, the water was forced up through the well in large quantities, and injured the land around. Once made, the communication could not be stopped. In Italy, Greece, and Egypt, are hills of broken pottery. In Denmark the celebrated kjokken middens are not less remarkable; and there is scarcely an ancient town that does not show an accumulation of material from five to fifteen feet in thickness.

Thus it appears that man not only may influence, but has very seriously and largely influenced, both organic and inorganic nature. So largely is this the case, that even the immediate results are beyond measurement, and what the ultimate and incidental effect may be it is altogether impossible to estimate.

Mr. Marsh's book is a little overlaid with matter already familiar, and diverges occasionally from its professed object—that of recording the influence of man on nature; but it is a valuable contribution to the physical geographer, especially in those departments of his science which bear directly on geological questions. We are bound, therefore, to welcome its author, and thank him for his labours.

THE NEW ZEALAND FLORA.*

At the request of the Colonial Government, Dr. J. D. Hooker has published the first part of a Handbook of the New Zealand Flora. It contains the flowering plants and ferns with their allies. The second part, which will be shortly published, will contain the remaining orders of Cryptogamic plants, with index, catalogue of native names and of naturalized plants. Dr. Hooker published in 1854–5, the second part of the 'Botany of the Antarctic Expedition of Sir J. Ross,' containing the Flora of New Zealand, in two volumes, quarto, with 130 coloured plates of New Zealand plants, including 1,060 species. No one was better fitted to draw up a compendious Hand-

* 'Handbook of the New Zealand Flora: a Systematic Description of the Native Plants of New Zealand, and the Chatham, Kermadec's, Lord Auckland's, Campbell's, and Macquarrie's Islands.' By J. D. Hooker, M.D., F.R.S., L.S., and G.S. 8vo. London: Reeve & Co. 1864.

book; and although the present work is confessedly and necessarily incomplete from the want of materials, still it gives a good view of the orders, genera, and species of the islands. "Much remains to be done towards the botany of the Northern Island especially; of the whole province Taranaki, nothing is known; and except the Ruahine range by Colenso, no mountain region has been approximately well explored. Then, too, of the outlying islands, as the Kermadec and Chatham Islands, very little is known, and of Bounty or Antipodes Island, nothing; whilst much remains to be collected on Lord Auckland's group, Campbell's Island, and Macquarrie Islands. The materials are still wanting for a comparison of the volcanic mountains of the Northern Island with the primitive or other mountains of the Middle Island, a comparison essential to make, before the geological or climatic relations of the Flora of either island can be ascertained."

Dr. Hooker gives the following interesting details relative to the labours of those who, as collectors or authors, have contributed to our knowledge of the New Zealand Flora.

In August, 1769, Sir Joseph Banks and his companion, Dr. Solander, visited the islands in Captain Cook's first voyage, and collected in Poverty Bay, Tegadoo, Tolaga, Opuragi, the Thames River, Bay of Islands, Queen Charlotte's Sound, and Admiralty Bay. They obtained about 360 flowering plants and ferns, had folio drawings made of most of them, and excellent manuscript descriptions.

In 1772, Captain Cook again visited New Zealand, accompanied by the two Forsters, Reinwold and George (father and son), and by Dr. Sparrman; they collected at Dusky Bay and Queen Charlotte's Sound. Their herbarium amounted to only about 160 species of flowering plants and ferns.

In 1777, Captain Cook, during his third voyage, visited New Zealand. On this occasion, Mr. Anderson, his surgeon, was the botanical collector, who obtained very little indeed, and nothing of any importance.

In 1791, Captain Vancouver arrived in Dusky Bay, on his way to survey the coasts of North-west America, having with him as surgeon Mr. Archibald Menzies, a very assiduous collector of flowerless plants, who procured many species of *Filices*, *Musci*, and *Hepaticæ*.

In 1822, Captain Duperry visited the islands in the French discovery corvette 'Coquille,' when one of his officers, the late Admiral D'Urville, made excellent collections.

In 1827, Captain (afterwards Admiral) Dumont D'Urville again visited New Zealand in the same ship, renamed the 'Astrolobe,' accompanied by an able naturalist, M. Lesson, when additional botanical collections were made in Cook's Straits, the Thames River, and the Bay of Islands. The materials of this voyage (containing upwards of 200 flowering plants and ferns) were published by M. A. Richard, in his 'Essai d'une Flore de la Nouvelle-Zélande,' with folio plates. (Paris, 1832.)

In 1825, Mr. Charles Fraser, then superintendent of the Sydney Botanic Gardens, landed for one day in the Bay of Islands, and made a small collection of dried plants. He, however, procured more living

ones, some of which were amongst the first plants of the islands which were introduced into European gardens.

In 1826, and again in 1838, Allan Cunningham, the eminent Australian botanist and explorer, made extensive botanical explorations in the northern parts of the Northern Island, chiefly at the Bay of Islands; and in 1833 his brother, Richard Cunningham, (Fraser's immediate successor in the Sydney Gardens), was sent in Her Majesty's ship 'Buffalo' to procure timber for the Australian government. The results of the labours of the brothers, and especially of Allan, whose arduous exertions in the islands led to his untimely death at Sydney in 1839, added considerably to the known Flora, and were collected by Allan into his 'Floræ Novæ-Zelandiæ Præcursor,' which was published by Sir W. J. Hooker, partly in his 'Companion to the Botanical Magazine' (vol. ii.), and partly in the 'Annals and Magazine of Natural History' (vols i., ii., iii.).

In 1840 and 1841, the French frigate 'L'Aube,' and in 1842–3, another, the 'Allier,' made a lengthened sojourn at the islands. During those occasions, M. Raoul, a very intelligent medical officer, diligently explored Banks's Peninsula and the Bay of Islands, making excellent collections at the former locality especially; most of the new species discovered were published first in the 'Annales des Sciences Naturelles' (series iii., vol. ii., p. 113), by MM. Raoul and Decaisne; and more recently were described and figured in a beautiful work, entitled 'Choix des Plantes de la Nouvelle-Zélande,' which further contains thirty plates, and an enumeration of all their known New Zealand plants.

In 1841, the Antarctic expedition visited the Bay of Islands, when accompanied by his friend the Reverend W. Colenso and by Dr. A. Sinclair, during a part of the time Dr. Hooker was enabled to explore the neighbourhood very fully, and to add largely to the Cryptogamic Flora.

In 1847–9, Capt. Stokes, R.N., in Her Majesty's ship 'Acheron,' surveyed the coast of New Zealand; he was accompanied by Dr. Lyall, who made very large and excellent collections, especially of flowerless plants, on various parts of the coast, but chiefly of the Middle Island.

The other collectors to whom Dr. Hooker is principally indebted for the materials published in the 'Flora Novæ-Zelandiæ,' are, firstly, the Reverend W. Colenso, who, during many successive years, has collected throughout the whole length of the Northern Island, with great care and skill, discovering more new and interesting plants (especially on the Ruahine Range, Tongariro, Hikurangi, &c.) than any botanist since Banks and Solander. The late Dr. Andrew Sinclair, R.N., F.L.S., formerly Colonial Secretary, a man of great attainments in many ways, certainly ranks second to Mr. Colenso. He collected very copiously in the Bay of Islands, the Auckland districts, and in the Nelson mountains, and was engaged in a botanical exploration of the Southern Alps in company with Mr. Haast, when he was drowned in the Rangitata river.

The first Alpine collections were made by J. T. Bidwill, Esq., of Sydney, who was the earliest explorer of the interior of the Northern

Island; and in 1839, ascended the lofty, active volcano Tongariro, incurring considerable danger.

The same mountains have been still better explored by Dr. Munro, who has added many beautiful Alpine species to the 'New Zealand Flora.'

In 1840, Dr. Dieffenbach visited many parts of the Northern Island and northern part of the Middle Island, and is the first person who ascended Mount Egmont.

The great opportunities enjoyed by the distinguished geologist and explorer, Julius Haast, Esq., F.L.S., F.G.S., Government Geologist of Canterbury, have been used to the best advantage in the furtherance of botanical science, he having contributed more new species to the Flora of the islands than any collector since Mr. Colenso.

From the Otago province, Dr. Hooker had an excellent herbarium of Dunedin plants, made by Dr. Lander Lindsey, F.L.S.; and more recently, very extensive and valuable collections, containing much novelty, from the Alps of the interior and west coasts, by another eminent geologist, Dr. Hector, F.G.S., Government Geologist, and Mr. Buchanan, his assistant.

To render the Handbook more complete, Dr. Hooker has included Chatham and Kermadec Islands, Lord Auckland's group, and Campbell's Island. Of about 100 flowering plants, natives of these small groups, no less than 27 are hitherto unknown in New Zealand proper, including three genera and twelve most conspicuous and singular species—*viz. Ligusticum latifolium* and *antipodum*, *Pleurophyllum* (two species), *Celmisia vernicosa*, *Gentiana* (two species), *Plantago antarctica*, *Chiloglottis cornuta*, *Antherieum Rossii*, *Rostkovia* (two species).

Of the 303 New Zealand genera of flowering plants described in this part, about 252 (containing 222 species and 51 representatives) are common to Australia; 174 (containing 11 species and 32 representatives) to South America; 31 are peculiar to the group (comprising 59 species); and 6 (with 20 species) are found in the Pacific Islands and elsewhere, but not in Australia or South America.

Again, of the 935 species of flowering plants, 677 are peculiar to the Islands, 222 are Australian, and 111 American. There are, further, 51 Australian representative, and 32 American representative species.

Comparing New Zealand with Europe, these countries have 115 genera and 58 species in common, the latter including many water-plants and several land-plants, which are doubtful natives. Of these European genera, the shrubby *Veronicas* and *Ligusticum* are the only ones that appear to be vastly more numerous in New Zealand than in Europe.

The work is a most able and valuable one, and cannot fail to promote the study of botany in New Zealand, and thus to add to our knowledge of the distribution of plants. It is prefaced by brief outlines of botany from Bentham's 'Flora Australiensis,' with a glossary, and a classification of the orders, and genera.

FLORA OF THE BRITISH WEST INDIAN ISLANDS.*

By the exertions of Sir William Hooker we are now in the fair way of having a complete series of Colonial Floras, under the patronage of Government. Dr. Grisebach's work on the Flora of the West Indies is one of them. The concluding part has just been published. The British Government granted 300*l.* to meet the necessary expenses. Dr. Grisebach has had free access to the Hookerian Herbarium and to that of the British Museum. He has, moreover, received collections from various botanists who have visited different Islands in the West Indies. This Flora is intended to be a synopsis of all flowering plants and ferns as yet known to inhabit the British West Indian possessions. Some cultivated plants are noticed which are said to be naturalized in the country.

"Though reaching beyond the tropics (N. L. 10°—27°), the West Indian Islands present an entirely tropical character in their vegetable productions, and the Northern Bahamas in this respect are quite distinct from the opposite continental shore of Florida, from which it is separated by the Gulf-stream; while Trinidad, lying almost contiguous to the Delta of the Orinoco, partakes of the Flora of Venezuela and Guiana. Jamaica, again, from its mountainous character and more distant position—most of the Leeward Islands, from being wooded volcanoes—and the majority of the Windward ones, with a dry climate and a low calcareous soil—form three divisions of this tropical archipelago, which show as many peculiarities. Thus the whole of the British West Indies, as comprised in this 'Flora,' may be divided into five natural sections, each with a distinct botanical character, and including the following islands, the geographical area of which is added according to the 'American Almanac for 1858,' and other sources:—

			English square miles.
I.	27°—21° N. L.	Bahamas	5,420
	21°	Turk Islands	400
II.	19°—18°	Jamaica	5,470
III.	Western Caribbean Islands (most Leeward, and including some of the Windward Islands).		
	18°	Virgin Islands	140
	17°	S. Kitts	70
	„	Nevis	30
	16°	Montserrat	50
	15°	Dominica	290
	14°—13°	S. Lucia	225
	13°	S. Vincent	130
	12°	Grenada and Grenadillos	155
IV.	Eastern Caribbean Islands (most Windward, and some Leeward Islands).		
	18°	Anguilla	30
	17°	Barbuda	90
	„	Antigua	100
	13°	Barbadoes	170
	11°	Tobago	190
V.	10°	Trinidad	2,000

Thus the territory comprised may be estimated as amounting to about

* 'Flora of the British West Indian Islands.' By A. H. R. Grisebach, M.D., F.L.S., Professor of Botany in the University of Göttingen. London: Lovell Reeve & Co. 1864.

15,000 English square miles, or nearly twice as much as the area of Wales. Haiti alone is nearly twice as large as the whole of the British West Indies; Cuba surpasses them almost three times, and this will account for the fact that, considerable as were the materials at command, and great the exertions of so many excellent collectors, the number of novelties in the 'Flora' is, comparatively speaking, small, while Cuba affords a daily increasing number of unpublished species. Considering, at the same time, how neglected by botanists Cuba has been, if we compare it with the standard works of men like Jacquin and Swartz, whose publications with regard to the West Indies were almost confined to the British possessions, it will appear probable that by far the greatest part of the plants of our territory consists of old species, these indeed being the foundation of our scientific knowledge of the Flora of tropical America."

Almost all the principal authors who have written on West Indian plants belong to the last century, when nothing was known of a natural arrangement, and no synopsis has been previously given of the Flora, and of no part of the British West Indian Islands has a tolerably complete 'Flora' ever been published since the time of Patrick Browne, whose 'Flora of Jamaica' appeared in 1756. Among the writers on the West Indian Flora may be mentioned Sir Hans Sloane, Linnæus, Plumier, Jacquin, Olaus, Swartz, Vahl, Tussac, Lunan, Descourtilz, Hamilton, Maycock, Macfadyen.

The author has followed pretty nearly the Candollean system, except that he has given up the Monochlamydeous division, and incorporated the Apetalous plants with the other sub-classes of Dicotyledons. The work has been executed with great care, and the author has been aided in his labour by Dr. Hooker. This publication supplies a desideratum which has been long felt, and its execution reflects the highest credit on Dr. Grisebach. A tabular arrangement is given of the natural orders according to the typical characters and a copious Index is added.

AUSTRALIAN FLORA.*

Mr. Bentham and Dr. Muller have published the second volume of their 'Australian Flora,' containing the species included in the Orders Leguminosæ, Rosaceæ, Saxifrageæ, Crassulaceæ, Droseraceæ, Halorageæ, Rhizophoreæ, and Combretaceæ. The first of these Orders, the Leguminoseæ, occupies 424 pages. Excellent analyses are given of the genera and of the species, and the publication is in every respect worthy of the botanical reputation of its authors. The services of Dr. F. Muller, the superintendent of the Melbourne Botanic Garden, have been of great value. He has already published works on the Australian Flora, and is placed in circumstances which have enabled him to clear up many doubts and difficulties which a botanist resident in Britain could not have accomplished. The work is a fit companion to the 'New Zealand Handbook.'

* 'Flora Australiensis: a Description of the Plants of the Australian Territory.' By George Bentham, F.R.S., F.L.S.; assisted by Ferdinand Müller, M.D., F.R.S. and L.S., Government Botanist, Melbourne, Victoria. 8vo. London: Lovell Reeve & Co. Vol. II. Pp. 521.

BRITISH AND GARDEN BOTANY.*

Mr. Leo H. Grindon, Lecturer on Botany in Manchester, has published a work on this subject, containing descriptions of the flowering plants, ferns, and trees indigenous in Great Britain, with notices of all plants commonly cultivated in this country for use and ornament. The work is intended to be popular, and it is prefaced by a brief introduction to the study of Botany. The author takes credit to himself for having published a work superior to all others as regards the intelligible way in which the natural orders are described, and as regards the excellence of the Key for finding out the particular families, genera, and species of plants. In place of sounding forth his own praise, and contrasting his own work with others, we think that the author would have acted more judiciously if he had followed Solomon's rule—"Let another man praise them, and not their own mouth; a stranger, and not their own lips." He thinks the Key in his own work superior to those given by Babington and Bentham, because among other things it does not require the ripe fruit to determine the plant; the learner he says can find out the name of the plant while it is in flower. We do not know that he has completely succeeded in this, and in some cases he has actually had recourse to the ripe fruit as part of the characters in the Key. Moreover we are doubtful whether the fruit is not in many cases absolutely essential to determine the plant with accuracy, or at all events with scientific precision. Mr. Grindon probably thinks that for popular works such minute accuracy is not required. The author states that his desire is "to introduce the lover of plants by the easiest and pleasantest path, to an intimate knowledge of everything growing wild in the field and woods, upon the shores, in the streams, and on the mountains of our native islands, and to give along with this some few particulars respecting such flowers and trees cultivated in gardens, shrubberies, and greenhouses, as are frequent and likely to attract attention." No generic characters are given, because the author says, "Genera can only be learned from the contemplation of many species of a genus, and as a very large number of British genera contain only one native species each, there is nothing for the student to compare and collate." We are disposed to think that the study of genera is far more important than that of species, and we would rather see our young students attending primarily to orders and genera than entering into the minutiæ of specific distinctions, more especially as given in some works of the present day. There can be no doubt that some have expressed a desire for a book which would treat of the common garden plants as well as of the native ones, and to a certain extent this work is meant to supply the desideratum. It is a combination of what is found in other introductions to Botany with a British flora. We are disposed to think that the two are best separate, and that the bulk of the present work will prevent it from being used as a field-book. The great use of

* 'British and Garden Botany.' By Leo H. Grindon, Lecturer on Botany in the Royal School of Medicine, Manchester. London: Routledge.

a British flora is in the field, and a botanist would find it no easy matter to climb the hills with such a heavy tome in his pocket. Still the book may be useful to home botanists who are content with easy walks in the garden.

On a cursory glance we have noted some inaccuracies. *Ranunculus sceleratus* is said not to be found in Scotland, which is a decided mistake; the plant is tolerably common. *Trollius europæus* is noted as being found in the lowlands of Scotland, whereas it extends high up on the mountains. Also *Geranium pyrenaicum* is spoken of as being naturalized in Britain and Ireland. The plant is undoubtedly wild in many parts of Scotland. *Erica ciliaris* should have been mentioned as being found in Ireland as well as England. *Sagina nivalis* is not recorded as a British plant. It is found abundantly on Ben Lawers, and other Scotch mountains. We cannot agree with the author in thinking *Alsine rubella* as not distinct from *A. verna*. Little Craigindal is said to be the only locality for *Astragalus alpinus* in Britain, whereas the plant occurs also in Clova, where it was first discovered. *Saxifraga Hirculus* is put doubtfully native of Scotland. The plant has been found in several localities in Scotland truly wild. *Orobanche rubra* is not confined to the Western shores of Scotland; it is also found on the Eastern shores. *Œnanthe crocata* cannot be called uncommon in Scotland. *Crithmum maritimum* is not noticed as occurring plentifully at the Mull of Galloway and other parts of the South-west of Scotland. *Scirpus Savii* also is not mentioned as being a Scotch plant found also in Galloway. There are many other mistakes and omissions of a similar character which call for careful revision. There is a deficiency of woodcuts, and those which are given are not well printed. Indeed the general typography of the book is not first-rate.

SOUTH AFRICAN BUTTERFLIES.*

One of the chief discouragements attending the pursuit of natural history in many parts of the world is the great difficulty which collectors find in identifying their specimens, or in obtaining any reliable information respecting them. Many a settler in a remote colony with a sufficiency of leisure, and not without inclination for the study of natural objects, has been deterred by the want of books of reference, such as those which assist the zoologist or the botanist in our own country. This deficiency, so far as it affected the butterflies of South Africa, has been very admirably supplied by Mr. Roland Trimen, the first part of whose work, containing five of the ten families of Rhopalocera found in South Africa, is now before us.

* 'Rhopalocera Africæ Australis: a Catalogue of South African Butterflies, comprising Descriptions of all the known Species, with Notices of their Larvæ, Pupæ, Localities, Habits, Seasons of Appearance, and Geographical Distribution.' By Roland Trimen, Member of the Entomological Society of London. Part I.—'Papilionidæ, Pieridæ, Danaidæ, Acræidæ, and Nymphalidæ." Cape Town: W. F. Mathew, Steam Printing Office, St. George Street. 1862.

A short introduction contains a summary description of the habits and transformations of butterflies in general, with so much of their structure and anatomy as, taken in connection with the single plate at the end of the part, may serve to render intelligible the characteristic distinctions of the genera and species given in the body of the work. The description of each species includes the name with a list of synonyms; a detailed account of the characters of the male and female, larva, pupa, and varieties; followed in many instances by a very readable and pleasant notice of the peculiar habits of the insect, its mode of life and geographical distribution; concluding with a reference to the various localities in South Africa where it has been taken.

Of the fifteen families of butterflies, ten only are represented in South Africa. The first family, Papilionidæ, of which about four hundred species have been described, "is very widely distributed throughout the greater part of the world, and contains some of the largest and most splendid butterflies known." "Only eleven species have hitherto been captured in South Africa." In Britain we have a single species, the well-known swallow-tail butterfly, P. Machaon. The beauty of the Papilionidæ attracts the notice even of the uncultivated savage. "The natives of Darnley Island are accustomed to capture O. Poseidon, and securing it by one end of a long thread, they fasten the other end of the thread to their hair, allowing the insect to flutter round their heads."

The species of the second family, Pieridæ, familiarly known as the "Whites," are numerous in South Africa. Mr. Trimen's remarks on this group remind the British collector of the habits of our native "Whites." The Pieridæ are perhaps of all butterflies most inclined to be gregarious, and sometimes appear in almost incredible numbers. The writer once encountered in a valley in the South of Palestine a flight of butterflies, apparently P. Cratægi, which for a quarter of a mile resembled flakes of falling snow, the air above and on all sides being literally filled with them.

The South African Danaidæ comprise four species only, characterized by ochreous and white markings on a ground of velvety brown or black. Of D. Echeria, the author says:—"The flight of this handsome insect is more graceful and floating than that of any other South African butterfly I have seen on the wing. At the Knysna, where it was common in the woods, it was one of the earliest on the wing of the forest butterflies, and very pleasant it was to stand quietly in some dewy open, and watch Echeria take her gentle flight through the cool air. On a warm still day this species will keep at a considerable elevation, floating across an open spot, flapping its wings twice or thrice, and then quietly pitching on some projecting twig, remain motionless, generally with the wings closed, and hanging downwards. On a windy day they fly lower and settle more frequently, when they are usually not difficult to capture."

The family Acræidæ is essentially an African one. Thirty-five of the forty-six species enumerated by Mr. Doubleday, in the 'Genera of Diurnal Lepidoptera,' being found in Africa and its islands. Of the remaining eleven, two are Asiatic, eight American, and one

species from Australia. "The Acræidæ frequent the open parts of woods, and even the more shaded parts, where only here and there a ray of sunshine that has stolen through the dense foliage of the trees plays on the scanty undergrowth of low shrubs or herbage. Their flight is rather slow and feeble."

The fifth family, Nymphalidæ, contains a large proportion of the butterflies with which we are most familiar. Mr. Trimen describes thirty-four species as natives of South Africa. This number exceeds by four that of the representatives of the same family in Britain; one species, P. Cardui, being common to both countries, and, in fact, to almost every temperate or tropical part of the world. The writer recollects having had an eager but somewhat circumscribed chase after this insect on the apex of the Great Pyramid.

It is not too much to say, that the scientific entomologist will find the present volume, in its typography and general arrangement, executed on the most approved model for works of this kind; and that the amateur who collects the splendid butterflies of South Africa will admit that a new zest has been imparted to his work, by a ready access to rich and varied stores of information.

CHEMICAL ANALYSIS.*

In noticing a work on Chemical Analysis, it might not be without interest to the general reader if we could give, in untechnical language, a general outline of the method pursued in this most interesting branch of study. But the difficulties in the way of this appear to us insuperable.

Chemistry has been defined as the science which teaches us the properties of elementary substances, and of their mutual combinations. Chemical Analysis is the art—founded upon a knowledge of these properties—of separating these substances one from another in mixtures and combinations, and determining the exact amount of each present.

We are to-day acquainted with sixty-four elementary forms of matter, or, at all events, substances which no means now at our disposal will enable us to resolve into simpler forms. The mutual combinations of these elements are infinite in number.

Of the elements a few are gaseous, two are liquid, and the rest are solids, mostly belonging to that class of bodies which are termed metals. Presenting many resemblances which allow us to class together several substances in various groups, according to many relations; each one, nevertheless, has a distinct individuality, and possesses characteristics which permit us either to fix it in some definite compound, or to isolate it altogether, and thus determine the exact proportion present in whatever combination it may exist.

* 'A Manual of Chemical Analysis, Qualitative and Quantitative. For the use of Students. Part I. Qualitative. Part II. Quantitative.' By Henry M. Noad, Ph.D., F.R.S., &c. London: Lovell Reeve & Co., 1864.

With the more common constituents of our earth, the means of identification are comparatively simple. Supposing a mixture containing all these, six general tests divide them at once into six groups, and thus one great step is taken towards their individual recognition. The further steps are indeed not so simple, but slowly and surely the student proceeds until he has recognized every one of these bodies by some decisive reaction.

But the detection of a body which is made in a qualitative analysis, and its complete separation and determination by weight in what is called a quantitative analysis are two very different matters. The first is a comparatively simple proceeding; to the latter there is sometimes an insuperable obstacle, and it becomes necessary to infer the amount of a substance by the difference remaining when everything else in a given weight of a mixture has been determined.

The reader thus sees that analytical chemistry is no child's play. To pursue it successfully requires no little skill in manipulation, no little perseverance, and above all things, no little patience. To students gifted with these, few pursuits are more fascinating; but without them, few pursuits probably are more disappointing.

With regard to Dr. Noad's book we have but little to say, and that little must be in commendation. To those who commenced the study of chemistry fifteen or twenty years ago, few books are better known than the excellent manual which Dr. Noad wrote, we believe, for the Society for the Diffusion of Useful Knowlege. The present work is the analytical part of the former book brought up to our present knowledge of the subject. The quantitative part is a compilation of all the best processes which have been devised, made by one thoroughly acquainted with analysis; and although the book is stated to be "for the use of students," this part will serve as a work of reference to those whose students' days may be said to have passed.

THE ASTRONOMICAL OBSERVER.*

It is not the good fortune of many who take a great interest in Astronomy to possess an equatorially-mounted telescope; and to such as have only the use of an instrument mounted on a plain stand, the observation of objects invisible to the naked eye presents some difficulties. By the compilation of this Hand-book, Mr. Darby has rendered an essential service to amateur astronomers, and more especially to those who cannot afford an equatorial; for the most useful feature of the work, and an original one, is that directions are given for finding objects with a plain telescope, the stars visible to the naked eye serving as pointers to the invisible objects.

The work consists of a catalogue of the constellations with the most interesting telescopic objects,—nebulæ, clusters, and double stars,

* 'The Astronomical Observer. A Hand-book to the Observatory and the Common Telescope.' By W. A. Darby, F.R.A.S. London: Hardwicke. 1864.

in each. For every one of these, the Right Ascensions and Declinations brought up to 1865 are given; and besides these there are, as often as possible, directions similar to the following for finding the great nebula in the constellation Andromedæ: "An imaginary line drawn in the heavens from the star β Andromedæ, over the star μ Andromedæ, and produced as far again beyond, will place the nebula in the field of the telescope, with a low power eye-piece."

We should have said that the catalogue has been specially prepared with reference to the large maps of the Society for the Diffusion of Useful Knowledge; and that the possession of those maps is essentially necessary to its use by the observer with a non-equatorial telescope.

The introduction contains valuable instruction in the use of instruments, catalogues of test objects, and a table of Refractions which will be found very useful.

PAMPHLET.

Sericulture in Oudh.*

Dr. Bonavia has published, in the form of a pamphlet, printed at Lucknow, during the year just closed, an account of the advance and prospects of the acclimatization of the silkworm, and of the production of silk in the province of Oudh, which, considering the short time that the experiments have had to bear fruit, may be considered as encouraging. Silkworm experiments with China and Cashmere worms have been conducted at Fyzabad, Seetapore, Baraitch, as well as at Lucknow; the latter under the superintendence of Dr. Bonavia. The China worms, however, became very sickly in the month of October, which he attributes to the alternations of temperature—the hot days and cold nights of that month. Nor could they be reared during the cold months of November, December, and January. The Cashmere worms did not yield very favourable results at first, the cocoons being difficult of reeling, and the thread often becoming entangled and continually breaking. Nevertheless, a report of the Agri-horticultural Society of India states that the native reelers, after a week's training, improved greatly, and the quality of the silk is described as excellent, though rather uneven. Two other kinds of worm have been experimented on, namely, first the Boro-Pooloo silkworm of Bengal, which produced good cocoons, which reeled very well. This, which is described as a very good sort of worm, produces cocoons for the most part perfectly white, but many are yellow, and some white with a greenish yellow tinge, and of it Dr. Bonavia remarks, that if he were rearing silkworms for commercial purposes in Oudh, he should certainly prefer, for the winter crop, the

* 'Sericulture in Oudh.' By Dr. E. Bonavia, Hon. Sec. Agri-horticultural Society of Oudh. Lucknow: R. Craven. 1864.

Boro-Pooloo, either to the Cashmere or the other species. This other species is the Bokhara worm, which yielded cocoons, firm, large, and full of silk. The sudden heat, however, of the middle of April caused them all to turn yellow and die. The thread, too, turned out to be weak, and did not reel easily. But it is the China and the Boro-Poolo which appear to offer the best prospects of success, the former a monthly worm, that is, taking about thirty-three days from the time of hatching to the birth of the next generation, which, however, can only be reared in Oudh in June, July, August, and September; while the latter is an annual, and can easily be reared in February and March. In November, December, and January, on account of the cold and the absence of leaves,—and in April and May, on account of the dry heat, no silkworms can be reared with advantage on a large scale in Oudh, but if the proper temperature can be maintained, small quantities may be reared for the purpose of keeping up the stock.

Large and lofty mulberry trees, though apparently they contain plenty of food, are not of the most useful kind; low and wide-spreading trees are the best, because the leaf-gatherers are able to walk round the trees, using both hands to pluck leaves, and every arrangement that saves time and labour is gain. In small experiments the worms were kept in trays made of strips of bamboo, woven into mats, and the dry leaves were constantly removed, and fresh supplied in their place. Great pains, too, were necessarily taken to preserve the worms from the attacks of ants, for a few ants on a tray will kill thousands of worms in a very short space of time, going about and biting one after another, and in this way narcotizing them, possibly with a view of carrying them away at their leisure, and producing effects very similar to those of a snake-bite upon larger animals.

The conclusions which Dr. Bonavia has come to with regard to whether silkworm-rearing in Oudh can be made a paying concern, are—that the China and Boro Pooloo worms can be easily reared in the months above indicated, and that besides the annual crop of the Boro-Pooloo, *three or four crops* can be had between June and September, from the China worms. A proper rearing house, furnished with everything that is necessary to regulate the temperature, is indispensable. It should be situated *in the midst* of a mulberry plantation, proportionate in size to the number of the worms. The *kind of mulberry* to be preferred, is that called by natives the "Dasee Shahtoot," which naturally grows tall, but must be kept down. *Morus cucullata* is only of use when the worms are in their first stages; but whatever kind of tree be used it will require abundant watering during the hot winds. The dry leaves of the trees, and the dung of the worms, will be profitably used as manure. Lastly, the reelers should be good ones, and the silk reeled for the home market. Silkworm operations are most likely to pay, not on land situated in the vicinity of cities, but on land which is now being cleared; since in the vicinity of cities necessaries, rather than luxuries, are most in demand, and such districts will always be found more profitably employed in producing food for man.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT BATH, September, 1864.*

It was necessary for us to omit some of the later proceedings of the British Association in our notice of the meeting last quarter, owing to the too near proximity of our day of publication with the meeting of these sections. We now proceed to supply the deficiency by recording abstracts of the most important papers, hitherto unrecorded, which were read before the Physical, Chemical, and Natural History sections; and we may add, that a Geological paper of importance will be found in our chronicles of that branch of science.

Physical Science. (Section A.)

On Tuesday, the first paper in this section was by Mr. F. Jenkin, who read the Report of the Committee on Electrical Standards. The object of the committee was, first, to select two suitable standards for electrical measurements, and next to decide upon their construction, so as to ensure agreement in measurement. Last year it was determined to measure by units, the fundamental standards being of time, force, and length. The committee now proposed to construct standards and issue them from Kew. Dr. Matthiessen found that lead was the best metal for their reproduction, or, at all events, the choice lay between lead and mercury.

A discussion then took place on spectroscopes, Mr. Gassiot reading a short paper on the "Adaptation of Bisulphide of Carbon Prisms," and the use of telescopes of a long focal length in the examination of the solar spectrum, with a view of counteracting the difficulties arising from change of temperature. Mr. Browning exhibited a new form of spectroscope, in which direct vision was obtained with a single prism. Professor W. B. Rogers stated that he had heard from Professor Cooke, of America, who was preparing to replace his bisulphide prisms by glass ones.

Professor Rogers then described Ritchie's improvements in the liquid compass, as used in the American Monitors. The liquid is a mixture of water and alcohol, and the band of needles is so placed that the disturbances arising from the oscillating motion of the ship is reduced almost to zero. The professor stated that he had seen one of these compasses taken by a porter, who ran with it backwards and forwards, up and down, from side to side of a rough floor, without any perceptible variation in the accurate pointing of the needle; and it

* Concluded from vol. i. p. 746.

might be swung round and round without causing more deviation than half a point.

Two interesting astronomical subjects were brought forward. One afforded a fine material for discussion, and has this advantage over most similar subjects, that it will be absolutely impossible for it ever to be decided. The Rev. T. Webb brought forward Hansen's hypothesis, that the centre of gravity of the moon did not coincide with the centre of the figure of the lunar globe; and hence there was a possibility that the visible hemisphere of the moon, in reference to its whole volume, was one gigantic mountain, in relation to which the other side would present a region of comparative depression, consisting of air, earth, and water, and peopled with a race of beings something like ourselves. The speaker said there was considerable interest in the various arguments which might be advanced on either side of this hypothesis; and the members of the section therefore entered into the discussion with spirit, without however, settling the question one way or another. The reverend gentleman subsequently exhibited a silvered glass speculum—a material which is now being applied to the manufacture of telescopes with great success; and Mr. Brothers exhibited some photographs of the moon, nearly a yard in diameter.

The second astronomical paper was by Mr. Birt. It entered into the subject of the telescopic appearance of the sun, and discussed the various sides of the "willow-leaf" controversy.

Professor Fuller then read a short paper, by Mr. Waugh, on the "Spectrum of Polarized Light," and another, by Mr. S. Highley, describing a cheap form of electric lamp.

The proceedings finally closed with a paper, by Mr. Birt, explanatory of a series of diagrams exhibiting the excessive variations of the wind and atmosphere, as recorded by Mr. Hartnup, the Liverpool astronomer, during three days before, and two days after, the great storm of December, 1863.

Chemistry. (Section B.)

On Tuesday, September 20, the first paper brought forward was by Professor Wanklyn, on a curious example of Etherification. Mr. Vernon Harcourt next read an interesting paper on the rate of Chemical Change. It would be out of our power to give anything like an intelligible abstract of this important paper in the space at our disposal.

Professor Roscoe then explained his Chemical Photometer for Meteorological purposes, and described the results which he had already obtained with it at Manchester. By means of this instrument it would be easy to obtain the daily curve of the chemical intensity of sunlight at any given spot. He employed for this purpose photographic paper prepared in such a way that the same tint on the paper always corresponded with a definite amount of light. Hence, if several prepared papers were exposed to a constant light for varying

periods of time, or for the same time, to light of different degrees of intensity, their tints would be found to vary in the same ratio as the light or the time. The time during which the papers were exposed was read off by the pendulum photometer, and the degree of tint attained was examined by the light of a soda flame.

Professor Rogers then described various pieces of apparatus which he had devised for testing illuminating gas chemically and photometrically. In the photometric testing he had discarded the candle, which was very inaccurate, and used a lamp in which was burnt oil of a certain specific gravity. The description of the various pieces of apparatus could not be rendered intelligible without diagrams.

Dr. Paul, in a paper " On Useful Applications of Slag from Iron Smelting," suggested the grinding it to dust, and mixing it with lime, when it could be moulded into bricks by powerful pressure. These bricks required no fire, but could be used at once, the influence of the atmosphere producing a slow kind of hardening.

Zoology and Botany. (Section D.)

An interesting account of the recent successful attempt to introduce the ova of the salmon into Australia, was read by Mr. T. Johnson.—

In January, 1864, 181 boxes of common deal, measuring 12 inches by 9 inches, by 5 inches deep, containing upwards of 100,000 salmon ova and 3,000 trout ova, were arranged in an ice-house, holding over 30 tons of Wenham Lake ice, on board the ship 'Norfolk.' On arriving at Melbourne, 11 boxes were retained, and the remainder forwarded to Tasmania. The ova were deposited in properly prepared gravel beds; and of the 103,000 sent out, upwards of 31,000 were alive. The death of so many on the voyage was ascribed partly to some of the ova not being in the best condition at starting, partly to the moss on which they were laid being in bad order, partly to some of the ova being frozen before starting, and lastly, to the bilge-water of the ship entering the ice-house. Considerable mortality also took place amongst the ova after being deposited on the gravel beds, but diminished as the season grew colder. The first fish was hatched in Tasmania on the 4th, in Melbourne on the 7th of May; the last on the 8th of June, 54 days after arrival at Tasmania, and 147 days after impregnation. On the 20th of June only 3,300 of the young fish were alive and healthy, so great has been the mortality amongst them. The author invited the co-operation of salmon-breeders, in order to determine the cause of this mortality and devise means to check it.

Dr. Daubeny read a paper, in which he assumed as an acknowledged fact, that species, as well as individuals, have a limited period of existence, but that certain natural contrivances are provided for postponing this inevitable termination to a later period than would otherwise happen were not such a provision made. It was suggested, that in the vegetable kingdom, the introduction of new varieties was an important means of prolonging the life of a species.

In a paper "On the Food of Birds," Mr. C. O. Groom pointed out that the food varied according to the season of the year; that it was wise to protect insectivorous birds; and that the house sparrow only lived upon grain during the winter months, and at other times of the year on insects and vegetables.

An elaborate paper "On the Pedicellaria of the Echinodermata," was read by Dr. Herapath. He regarded these structures as proper to the animals on which they occur, and not as parasites. Their forms are characteristic of the species on which they are found, so that various of the Echinodermata may be recognized by their Pedicellaria.

Mr. C. Spence Bate described the contents of an ancient Kitchen-midden, which he had examined, near the church of Constantine, on the north coast of Cornwall. A shell bed containing the limpet, smaller whelk, and mussel shells, was met with, together with bones of the sheep, lamb, and roebuck. A considerable quantity of pottery was also found.

A very interesting description of an ancient cranium, found in the course of excavations recently made at Gibraltar, by Captain Brome, was communicated by Mr. George Busk. The exact locality in the rock from which the skull was obtained could not be stated with certainty; but when first received, it was covered with a thick, hard concretion, composed in part of siliceous sand, to all appearance like sea-sand agglutinated by a calcareous cement. In general outline the Gibraltar skull resembles the Neanderthal calvarium, except that the supra-orbital projection is not so great; but it retains, besides the calvarium, the entire face, most of the teeth in the upper jaw, nearly the entire right temporal bone, with the external auditory opening, and the mastoid process, and a small portion of the foramen magnum. Compared with the three lower races of existing man, the Gibraltar skull most nearly resembles the Tasmanian, especially in its lowness. The nasal part of the face is broad and convex, the nasal opening is wide, and from the projection forward of the central part of the face, and the great width and rotundity of the jaw, the skull derives a peculiar and animal-like expression.

In a notice of some rare Scotch plants Professor Balfour stated that he had found Sagina nivalis, a Scandinavian plant, on Benlawers and on Binnain, a mountain near Ben More in Perthshire: also Phyllodoce cærulea on the Sow of Athole in Invernesshire. Specimens of several plants confined to single localities in Scotland were exhibited.

Physiology. (Subsection D.)

In an important paper "On the Inhalation of Oxygen Gas," Dr. W. B. Richardson pointed out that the influence of oxygen, when inhaled, was modified, 1st, by dilution of the oxygen; 2nd, by dilution of the blood; 3rd, by the activity of the oxygen; 4th, by the presence or absence in the blood of substances which stop combination. It is necessary that the oxygen should be in some measure diluted, for

neutral oxygen does not combine with the carbon of the blood unless it is diluted. The death of animals in pure oxygen is not by a narcotic poison, but by a process of negation. By a dilution of the blood to the specific gravity of 1,060 the absorption of oxygen is increased to a maximum; when further diluted, the absorption declines. Fresh oxygen prepared from chlorate of potassa increases the activity of the functions; but if exposed to ammonia, decomposing animal matter or even living animals, it loses its activity, and no longer combines with the blood. Alcohol, chloroform, opium, and certain alkaline products formed in the blood in disease prevented absorption of oxygen, and death not uncommonly took place from this cause.

The same physiologist communicated a paper "On the Physiological Effects of Tobacco," in which the composition of the products of combustion of tobacco, their physiological action on the body, and the effects of ordinary and excessive smoking were considered. The paper was full of detail, so that to furnish an intelligible abstract in a brief space is difficult. The author concluded by saying, that in the main, smoking is a luxury which any man is better without, but of nearly every luxury, tobacco is the least injurious. It is innocuous as compared with alcohol; it does infinitely less harm than opium; it is in no sense worse than tea; and, by the side of high living, altogether contrasts most favourably.

In an elaborate report "On the Physiological Action of the Nitrite of Amyle," Dr. Richardson pointed out the various effects which he had observed it to produce upon the animal body, amongst the most remarkable of which, we may especially refer to the violent action it induces in the heart, with dilatation of the capillaries, followed by diminished power of the heart and contraction of the extreme vessels. It possesses the power of so reducing the respiration and circulation, that a state precisely analogous to trance or catalepsy is induced. It is not an anæsthetic.

Various papers were read by Dr. Cobbold on meat, vegetables, fruits, and water, as sources of Entozoa. He described the various species of entozoa found in the flesh of animals used as food; he referred to the difficulty often experienced in detecting them, and stated, that eating raw or half-cooked meat, was a frequent means of introducing parasites into the human body, all danger of injury to man being avoided when a proper temperature is employed in cooking. From the fact of vegetables harbouring various small molluscs, the ova of entozoa may be introduced into the system, for multitudes of small parasites are not unfrequently contained in these molluscs. The more filthy the water or liquid manure employed to secure the fertility of the garden the more likely were the vegetables to harbour entozoa. The most careful washing was therefore necessary, and even soaking vegetables in brine before cooking might at times be advisable. Fruit, as far as the author knew, was never a source of entozoa. Fresh spring water was perfectly innocuous, but water stored in tanks often contained parasites and their ova. Drinking water into which the

carcases of dogs and other animals had been thrown should especially be avoided.

Dr. Boyd communicated an elaborate statistical paper on the measurements of the head and weight of the brain in 696 cases of insanity, of which it would be difficult to give a satisfactory account without constant reference to the tables with which the paper was illustrated.

Dr. William Turner related an example of that very rare description of cranial deformity, termed by Welcker, Trigonocephalus, which he had met with in a boy *æt.* five and a half years, the son of Irish parents. The peculiarity of this form of skull consisted in an absence of frontal eminences and consequent flattening or even hollowness above the eyebrows, together with a very remarkable beak-like projection of the forehead in the middle line. The characteristic shape was noticed in the head of this boy at the time of birth. His intelligence was quite on a par with that of children of his age and condition of life.

In a paper "On Obliteration of the Sutures in one class of Ancient British Skulls," Dr. Thurnam pointed out that in British dolico-cephali there is a great tendency to obliteration of the sutures generally, but that such obliteration is not of so frequent occurrence in the sagittal suture as to warrant the conclusion that the dolico-cephalism depends on the synostosis. In the great majority of cases the obliteration is of the prematurely senile description. The obliteration was compared with obliteration of the sutures seen in the African race, and referred to the same cause, *viz.* an exuberant ossification. The author was of opinion that the post-coronal depression frequently observed in dolico-cephalous skulls, may, in some instances, of ancient British skulls from the long barrows, be produced by artificial compression.

It was argued by Mr. J. S. Prideaux in a paper "On the Functions of the Cerebellum," that there is a constant relation between the size of the median lobe of the cerebellum and the motor power of the animal, and between the size of its lateral lobes and its sensibility.

Mr. Alfred Haviland communicated a paper "On the Hour of Death in Acute and Chronic Disease," in which he stated that the greatest mortality took place in the early hours of the morning when the powers of life were at their lowest ebb.

Dr. T. A. Carter gave an account of the origin and arrangement of the superficial branches of the lymph vessels in the liver of man and of the pig. His object was to show that there is a direct communication between the capillaries and the finest lymph vessels in this organ. In favourable sections he had seen very minute injected processes coming off from the hepatic capillaries and uniting with others to form a primary lymphatic radicle. He also described a peculiar relation between the hepatic artery and the lymphatics of the liver, two lymph vessels united at intervals by short transverse branches accompanying each branch of the artery. With each expansion of the

artery the lymph vessels are compressed, and their contents propelled towards the heart.

Dr. E. Crisp gave an account of the mammalia in the abdominal veins of which he had observed the presence of valves. He also read a paper " On the Size of the Blood Corpuscles in relation to the Size of the Animal, its Organization and Powers of Endurance," the object of which was to show that the opinion generally entertained that the largest animals in the same family had the largest blood globules, was erroneous in many instances.

Mr. R. Garner described a small organ situated at the base of the middle pair of legs of Corixa, an abuatic insect, by the passage of air through which he supposed the characteristic sound produced by the insect was occasioned.

Mr. J. T. Dickson read a paper " On Cell Theories," in which he argued against the formation of cells out of inorganic matter, on the theory of manufacture of Mr. Rainey. He then offered a cell theory in which he assumed life to be an essential element, existing in the molecules, of which a homogeneous mass is composed, the molecules aggregating to form nuclei, from which cells are developed.

An account of the composition and uses of the horse-chestnut was given by Dr. John Davy. His examination comprised the nut, leaves, wood, pith, and bark of this tree, and he concluded that it deserved more attention in an economic point of view than it had yet received.

NOTES AND CORRESPONDENCE.

On the probable Existence of the Repetition of Octaves in the Solar Spectrum. By C. Hilton Fagge, M.D., Lecturer on Experimental Philosophy at Guy's Hospital Medical School.

In his paper, in the October number of the 'Quarterly Journal of Science,' Mr. Balfour Stewart, while comparing the phenomena of radiant heat and light with those of sound, remarks that there is not a complete *octave* in the visible spectrum—that the most rapid undulations which give rise to the sensation of sight have less than double the velocity of those which are least rapid.

This observation suggested to me the thought, that, probably, just as the ear perceives the identity of one note with another which is an octave higher, so the eye would derive the impression of the same colour from two rays, the wave-length of one of which should be half that of the other, assuming both to possess the power of acting upon the retina. Thus one can conceive, that if our power of vision were *less limited*, the spectrum, with the actinic and thermal rays, would represent a scale in which the colours would repeat themselves in regular order, just as the notes do in the musical scale.

We have, I think, an evidence that this is the case, in a fact which had often puzzled me; I refer to the presence of violet beyond the blue in the spectrum, so far from the red, which, by its combination with the blue, would form violet. If the colours be arranged in a circle, the violet forms a gradation between the red and the blue, just as the orange does between the red and the yellow, and the green between the yellow and the blue: and the linear arrangement has always seemed to me to be an unnatural one. I now believe that the red which thus appears in the violet at the upper extremity of the spectrum, is not the red which is perceived at the lower extremity, but the red of an octave higher (so to speak), the lower edge of which happens to fall within the limits in which ethereal waves are capable of producing the sensation of light. It would follow, that if the actinic rays immediately above could be seen, they would appear as red light. It is of course no objection that after passing through certain liquids they appear as blue rays; for it is admitted that a change in their refrangibility, and in their wave-length, has then taken place.

It appears to me that this view suggests several interesting points for inquiry to those who are provided with the means of experimenting upon this subject. If the colours would repeat themselves in the spectrum were it not for the imperfection of our organs of vision, is it not probable that fixed lines and absorption bands may repeat themselves also? It is well known that the colour of a surface was found by Melloni not to affect its power of absorbing obscure heat, that is to say, heat of great wave-length. But Professor Tyndall,* with his more delicate apparatus, was able to detect the influence of colour, on the absorption even of obscure rays. Is it not likely that a coloured surface which absorbs visible

* 'Lectures on Heat considered as a Mode of Motion,' p. 289.

rays of a certain wave-length would also absorb, in preference, rays having half that wave-length—in fact, those situated an octave lower in the scale? The relation between the absorptive and radiating powers of bodies for rays of the same refrangibility has been compared to the phenomena of consonance: and we have in these phenomena a strict parallel for the idea which I have just ventured to throw out. Thus, to give an illustration,* Count Schaffgotsch, while experimenting on singing flames, found that the flame could be set in vibration by sounding not only its fundamental note, but also other notes nearly allied, such as the octave.

So, again, it might perhaps be found that corresponding to the bright yellow line produced in the spectrum by sodium, a line of great heat exists also among the non-visible rays, at the point where the wave-length is half that of the visible yellow ray; and absorption-lines may be found to exist in the lower part of the spectrum, in corresponding positions.† If this should be so, we should be able to ascertain the exact length of the different parts of the spectrum, and the distance at which a given ray repeats itself. I do not know how far these points may be capable of determination from mathematical data.

As I have myself no means of working out this subject experimentally, I have thought that it might be worth while to suggest these points as worthy of investigation by those who have greater facilities for testing their truth.

C. Hilton Fagge, M.D.

Guy's Hospital, Oct. 1864.

P.S.—I have since found that Sir J. P. Herschel* obtained light of a lavender-grey hue by concentrating the ultra-violet rays with a lens. He describes, however, these rays as "lying *far beyond* the ordinarily visible violet," so that they probably included rays of very different wave-lengths, collected together; and I do not think that this observation can be regarded as disproving the explanation which I have ventured to suggest, of the occurrence of the violet rays at the upper end of the spectrum. I cannot find that any writer on the subject has thought of it as a fact requiring to be accounted for.

* 'Phil. Mag.' Dec. 1857, p. 542.

† A tolerably close acoustical analogy for this supposition may be found in the well-known fact that, when those strings of musical instruments which produce the deeper notes are struck, besides the fundamental note, the octave is heard.

* 'Phil. Trans.,' 1840, p. 19.

On the Vast Antiquity of the Lunar Surface. By James Nasmyth.

The views I entertain on this subject are that, as a direct consequence of the small mass of the moon, and its comparatively large surface in relation to its mass, the moon must have parted with its original cosmical heat with much greater rapidity than in the case of the earth; consequently the moon must have assumed a final condition of surface-structure ages before the earth had ceased from its original molten condition. The moon, in all reasonable probability, never possessed an atmosphere or water envelope (it certainly has neither now), while the earth has both. The earth's atmosphere — and especially its ocean, when it existed in the first instance as a vast vapour envelope, ere the earth had cooled down so as to permit the ocean taking up its final position *as an ocean*—this mighty vapour envelope must have retarded the escape into space of the cosmical heat of the earth millions of

ages after the moon had assumed its final condition as to temperature; and we have every reason to conclude that it was the passing-off of the original cosmical heat of the moon and of the earth that induced those actions, which resulted in the present structure and condition of their surfaces.

It is from such considerations I am led to the conclusion that the moon's surface-features, down to their minutest details, present to our view objects the antiquity of which is so vast that the oldest geological formations of the earth (inconceivably ancient as they are) are *comparatively* quite recent.

Such considerations appear to me to enhance so greatly the deep interest which ever attends the examination and contemplation of the moon's wonderful surface, that I would earnestly urge those who agree with the soundness of these views to bear them in mind when next they have an opportunity to behold the marvellous details of the lunar surface, for I would fain believe that in so doing the interest of what is there and then revealed to them will be rendered vastly more impressive.

James Nasmyth.

Penshurst, Kent, Dec. 5, 1864.

Books received for Review.

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Journal of the Chemical Society. (Baillière.) (From the Society.)

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Proceedings of the Cotteswold Naturalists' Field Club for 1863. Plates. Royal 8vo. (From the Secretary.)

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CONTENTS OF No. VI.

OF THE

QUARTERLY JOURNAL OF SCIENCE,

INTO WHICH THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL

IS NOW MERGED.

APRIL, 1865.

ORIGINAL ARTICLES.

CHRONICLES OF SCIENCE.

NOTES AND CORRESPONDENCE.

NOTICE TO READERS.

The Editors will be glad to receive the printed Reports of all Scientific Societies (Metropolitan or Provincial), including those of Schools and Classes of Science, and of Naturalists' Field Clubs. Also Scientific Addresses, Reports, and Lectures.

Manuscript sent for approval must be accompanied with sufficient stamps to cover the return postage in case it should be deemed unsuitable. Observers in all branches of Science are invited to communicate briefly their new observations, but copies of these must be kept by Authors, as they cannot be returned if not considered suitable to the pages of this Journal.

Contributors are alone responsible for their opinions on Scientific subjects. The desire to publish both sides of a debated theory may often necessitate the insertion of views at variance with those of the Editors.

No notice whatever will be taken of anonymous communications.

THE QUARTERLY

JOURNAL OF SCIENCE.

APRIL, 1865.

ORIGINAL ARTICLES.

SCIENCE, POLITICS, AND RELIGION.

As a rule, the scientific world is too much engrossed with its legitimate occupations to bestow aught but a passing notice upon the expressions of feeling in regard to its action and influence, which emanate from those who are not directly interested in scientific pursuits, and it is only what may be termed its civil agitations that command its attention. Secure in the sense of its growing influence and irresistible progress, Science can afford to smile at the little squibs that are from time to time thrown on its path, and may safely permit its truths to be ridiculed or perverted by persons who conceive that such a course will conduce to their political popularity, or will enable them more readily to attain religious ascendancy.

But it is useful that scientific men should occasionally look up from their labours and cast a thoughtful glance around, not alone with a view to ascertain what the world thinks of their efforts, but also that they may be able to form an accurate estimate of the practical fruits of their occupations, correct the errors of the past, and resume their work with the additional experience that must inevitably result from such a survey. Keeping these objects in view, then, we feel ourselves justified in taking some notice of three or four circumstances that happened during the last quarter of the year 1864, all of which caused no little sensation at the time of their occurrence.

The first was the attempt, on the part of "some person or persons unknown" (excepting in name), to extract from the scientific world a profession of religious faith, a proceeding innocent enough in itself, but which, if it had not been arrested in time, would doubtless have inaugurated a period of coercion that must have militated against the progress of scientific inquiry. A few sincere and well-meaning scientific men signed the "declaration," which censured the attempt to bring Science and Scripture into antagonism, and which, as our readers are doubtless aware, was intended to be published as soon as a

sufficient number of signatures should have been obtained. The attitude, however, which was assumed by Sir John Herschel and others of high repute, nipped the project in the bud, and effectively suppressed the attempt that was being made by the originators of the movement to interfere with freedom of thought and to convey to the outer world a very false impression of the character and intentions of scientific men.

"*Qui s'excuse s'accuse*" is a proverb remarkably applicable to the present case. Let us suppose the compilers of the document to have been perfectly honest in their object and in their desire to obtain signatures, and that the scientific men of Great Britain had signed it with equal sincerity, what would the world have said when the bull was promulgated?

"Here is the *élite* of Science indulging in a protest against its own irreligion! What must *we* think of them if they have formed such a lowly estimate of themselves?"

Not desiring to be uncharitable, we will not meddle with the assumption that the originators of the document were sincere, but we venture to affirm that of the whole number of signatures that *might* have been appended had the movement progressed, about one-third would have been those of persons who honestly believed that their protest would be of service to Science as well as to Religion; an equal proportion would have signed in order that their names might not be omitted from the long list of F.R.S.'s and LL.D.'s which enriched the sheet, and the remaining third, lest their refusal should mark them as infidels.

There can be no doubt that from time to time works do appear, the publication of which should be condemned, but the antidote to these is the pen of the critic, honestly and fearlessly applied to meet each particular case, and not a general "confession of faith." Whilst a rightful censure upon irreligious works has never failed to bring them into disrepute, the issue of a document such as the one referred to above, would have had the effect of rendering such treatises popular, inasmuch as the attempt to interfere with free thought and unfettered inquiry would merely have served as a plea for their publication. The end aimed at would therefore not have been attained and, as Sir John Herschel very properly said at the time, the document would simply have proved a fresh element of discord in the "already too discordant relations of the Christian world."

The second event to which we would refer, was the attempt of the Right Hon. Benjamin Disraeli to cast ridicule upon those naturalists who have adopted the views of Mr. Darwin with respect to the origin of species. This escapade on the part of the leader of Her Majesty's Opposition was sufficiently ridiculous to afford a legitimate theme for the pages of 'Punch,' where the pencil of Mr. Tenniel exhibited it in its true light and with telling effect. But Mr. Disraeli's attack upon scientific investigators was something more than ridiculous; it was what he certainly did not intend it to be—very unbusiness-like and impolitic. Surely his conception of the scientific men of the present day must have been formed from those records of mediæval times, the

perusal of which has no doubt, in other respects, proved very beneficial to him in his literary career. But he should know that our *savans* no longer seclude themselves as formerly in the turrets of deserted castles, there to pursue their vocation by the flickering lamp of midnight, and exercising no further influence on society than the terror which their mysterious operations inspired in the surrounding peasantry. As a rule, their habits of observation enable them to reason with more accuracy than other men, and to arrive at more correct conclusions on those subjects to which their attention is earnestly directed. They will be apt to compare Mr. Disraeli's address with that delivered shortly afterwards by our aged Premier, when he treated of the progress of agriculture and the application of steam to tillage, and they will have no difficulty in perceiving in the one an abuse of intelligence and a bid for office at the expense of progress; and in the other, a laudable effort, during the tenure of power, to keep pace with the progressive spirit of the age. If Mr. Disraeli had shown some better cause for "going with the angels" than the desire to catch a few additional votes, by currying favour with extreme churchmen at the expense of charity and progress, he would have been listened to with respect; but as the matter now stands, it would appear that political instinct, rather than reflecting reason, was the motive force, and this new manifestation of "vis *conservatrix* naturæ" will afford, if anything, a fresh piece of evidence to Mr. Darwin and his school of the truth of the doctrine of natural selection! Mr. Disraeli's sneer at the attempts of our modern naturalists (many of whom, by the way, are ministers of the Established Church) to account scientifically for the differences of species, will be remembered by them at some future time; and if, as on a former occasion, he should propose to confer a special franchise upon them for their intelligence, his extra-parliamentary utterances on this occasion may serve them as a standard whereby to measure the sincerity of his professions and the value of the proffered boon.

We shall have occasion hereafter to refer more fully to the question treated with such levity by Mr. Disraeli, and will now pass on to the last occurrence, which we cannot say affected Science, but bore some relation to its progress: that was the promulgation of the Pope's Encyclical Letter, and its eighty modern errors.

Whilst the cry is everywhere "Educate, educate, educate!"—the miner, that his life may be less endangered; the agriculturist, that he may know better how to wrestle with natural difficulties, and employ more rationally the blessings of Providence; the merchant, that he may be something beyond a mere bartering creature; or the soldier, that he may be more intelligent than his rifle—the infallible head of that sect of Christians which claims to be the universal Church, decrees that the "knowledge of philosophical things," and that all "popular schools," must submit to ecclesiastical authority; that they must, in fact, be controlled by priests, who, little educated excepting in the mysteries of their faith, have assumed, and continue to assume the authority of the Almighty whilst they seek to fetter and restrict the action of that intelligence to which He has given almost unlimited freedom. And yet we really have no great fault to find with the eighty "errors," for

the only one that strictly relates to Science, No. 12, is literally correct. Who will deny it to be an "error" that "the decrees of the Apostolic See, and of the Roman congregations, fetter the free progress of Science?" Whatever they may have been two hundred years since, such "decrees" are innocent enough at present; and what is more, Catholics themselves who care about Science at all, are really more liberal in their views than many who profess to belong to a more tolerant faith. But whilst a few designing persons, or those sincere but unreflecting men who constitute the extremes of religious and political denominations, may applaud attacks upon Science, or sanction the attempt to cast stumbling-blocks in her way, the more moderate members of every section of the community, Protestants and Catholics, Liberals and Conservatives, all, indeed, whose support and approbation are likely to benefit scientific movements, will not fail to deprecate such an attitude on the part of the uninformed, and to share with scientific men their contempt of these unmeaning explosions of noisy ignorance. It is almost needless to say that the real tendencies of the age are towards unfettered thought, free inquiry, and an open opposition to priestly or clerical interference in scientific or secular affairs.

But it is not enough that we should point the finger of scorn at those who deride the exertions of scientific men, or that we should protest against the injustice of their assailants; it behoves us to inquire whether these attacks and sneers are justified by any apathy or indiscretion on the part of scientific investigators and professors. Are they performing their part in the great work of civilization? Do scientific tenets deserve to be branded as atheistical? (for that is the concealed inference intended to be conveyed by most of those who protest against modern theories). Are inquiries into the operations of natural forces calculated to elevate or to degrade the human mind? These are the interrogatories which scientific men should put to themselves, and they are the topics we now propose briefly to consider.

In regard to the first inquiry, it will be found that here, as in every other human pursuit, the fields before us are so immense, when compared with the plot over which we have passed, that the zealous practical philosopher cannot help feeling how slow is his progress and how great are his shortcomings. Of this truth we will adduce one or two illustrations.

It is but as yesterday that the streets of our great cities were illuminated at night by dismal oil lamps, few and far between, whose feeble light served the ends of the footpad, but afforded little aid to passengers or to the guardians of the night. Now there is gas and petroleum, and we shall probably be told that the world will shortly be favoured with the magnesium and electric lights for all purposes of illumination, and that we shall then have no more cause to dread the darkest night than the broad light of day. It is impossible to deny that, *theoretically*, great strides have been made in the art or science of illumination, and we should be deeply grateful to the students of physical science for the additional light that has been afforded to us, more especially for the promised improvement in the character of those

coast beacons that direct the wayfarer at sea. But if our cities and towns are now somewhat safer at night than they were before the introduction of gas (and there are many persons who but recently, during the garotters' reign, pronounced them less secure than formerly), is it to Science that the increased safety is due? Has she, in this respect, assumed her true position amongst our modern civilizers? We apprehend not; for when we consider that, by the employment of the physical and chemical forces, the blackest darkness could be dispelled, and our streets and suburbs illuminated with a clear and steady light but slightly inferior to that of the great "orb of day," exposing all the vice and crime and libertinage which are perpetrated under cover of the night, then, indeed, we feel that scientific men have still a glorious mission to fulfil, to render their discoveries available for social ends, increasing not the comforts only, but the safety of the human race.

Excepting that it has been employed in a small number of our coast lighthouses, and by a few of our leading investigators to aid them in their physical or chemical researches, magneto-electrical illumination (and still more the magnesium light) is little else than a curiosity which serves here and there to amuse and perhaps in some cases to instruct, limited scientific audiences.

It is beyond a doubt that Science will complete the work she has begun, and will render practically useful what is now theoretically valuable; and judging from some inquiries that were made of us in regard to the possibility of lighting up ironworks and factories (in both of which the requisite steam-power is easily obtainable) by magneto-electricity, shortly after the appearance of the article on this subject in our first Number,* we feel confident that the time is near at hand when the practical benefits accruing from the researches and experiments of scientific investigators will become manifest.

In the prosecution of such a work as this, chemists and physicists have no cause to apprehend either priestly interference or political sneers, and we would direct their attention to the motto that distinguishes this Periodical, as a watchword to guide them in their duty. To them it is especially appropriate. They have the power to dissipate our physical and moral gloom; to raise a vivid light above our cities; in our workshops; to penetrate our mines and tunnels with an artificial day! And so they may assist in the suppression of our vices and our crimes; may lighten toil, and render life secure. Are not these objects worthy of the exercise of man's best faculties? Can priest or politician teach us a more sacred duty? †

But if the magneto-electric mode of illumination is not becoming developed as rapidly as some might desire, the progress made in the employment of another form of electricity for purposes of intercommunication is most satisfactory, and exhibits at once the indomitable energy of our race, and its love of gain and conquest. Impelled by commercial

* Dr. Gladstone on "Lighthouse Illumination by Magneto-electricity." 'Quarterly Journal of Science,' vol. i. p. 70.

† Since this article was written, an account of a miner's electric lamp has been forwarded to us: it will be found in our Chronicle of Mining.

enterprise rather than by philanthropic considerations, the baffled and defeated electrician has once more allied himself with the wealthy and enterprising trader; and with replenished exchequer, they have set to work anew to bind the Eastern with the Western hemisphere. Guided by the practical experience of the past, and by the researches of the closet-investigator, they set out upon each trial with fresh precautions and improved materials, and so not only is the end brought nearer and nearer, but the collateral study and observation necessary for its attainment add a fresh fund of information to our mental treasury, and open out new fields for the practical application of the science investigated.

It will be a matter of deep interest to know whether the unfortunate and much-abused 'Great Eastern,' that triumph of modern engineering skill, will faithfully perform her task of depositing the cable upon the construction of which so much care has been bestowed; and the enterprising men who are engaged upon this second effort to link more closely the two great families of English people, may rest assured that their anxiety for the result will be shared by all scientific men and friends of progress.

Whilst we speak of the combination of commercial with scientific enterprise, we are once more reminded of our aged Premier's observations on the application of steam to tillage. If we remember rightly, Lord Palmerston threw out the suggestion that, as not every farmer can afford to purchase a steam-plough, capitalists should purchase and let them out on hire. No doubt he is aware that such a practice has long prevailed with regard to steam thrashing-machines, and that there are many persons who derive a handsome income from this source. But it has often been a matter of surprise to us, that during the recent mania for limited joint-stock companies, when they sprang up like mushrooms, some with avowed aims chimerical and laughable enough to have been fit subjects for a farce, had they not too often formed the basis of a very painful drama; that during this extravagant fever it should never have occurred to some honest speculator to establish a company for the purpose suggested by the Premier. Possibly such a project may have been set on foot, and have escaped our notice; but in all probability it was far too legitimate an enterprise for "bulls" and "bears."

Another combination of scientific and commercial enterprise to which the greatly abused Act might be applied with advantage is the utilization of sewage.

This subject has been much agitated of late, and its discussion belongs rather to the agriculturist than to the student of natural or physical science, but it may be satisfactory to the former to receive a word of encouragement to counteract the obstructions which ignorance and prejudice occasionally throw in his way. He certainly has the approval of the naturalist, who sees in his efforts to turn refuse matter to good account, a wise imitation of that Providence which knows no waste but which with the results of decay rejuvenates nature and clothes her in fresh beauty. But even these zealous operators are liable to adverse criticisms, and it is right that they should observe

and profit by the strictures to which they are subjected. A writer in a weekly contemporary remarked some time since that in passing over a field manured with "sewage," his nostrils were offended by the odour, and he expressed the hope that "the incense breathing morn" might not soon become a thing of the past. In our large towns, and more especially in those where industry has made the most rapid strides, this is already the case, and the pale-faced citizen is compelled from time to time to seek renewed health and strength in the open fields and country lanes. Certainly the sewage of those towns renders them at present still more unhealthy than they would otherwise be, and it sometimes taints the sources of our water supply, causing men to drink the poison as well as to inhale it. Still we should look with apprehension upon the pouring of this flood of noxious liquid over the fields that form a refuge from the overcrowded city, unless the most effective measures were taken to secure its complete deodorization. May greed of gain never do its evil work here as it has done in those districts where the injurious products of chemical manufactures have laid waste the country round, and where legislative enactments have been requisite to teach men their duty towards their neighbours. We recommend Mr. Disraeli to follow the example of his noble chief (who has been a great sufferer by the last-named evil), and to direct his attention to such objects as these. He would then succeed in gaining popularity amongst the class whose suffrages he more especially courts, "the agricultural interest," and would earn the respect even of the despised Darwinians, who would give him credit for seeking to alleviate the pains and penalties that accompany the "struggle for existence!"

Having thus briefly touched upon a few important scientific movements of a utilitarian character, in order to exhibit the necessity for increased vigilance and activity on the part of scientific men, we would now inquire whether their theoretical observations are deserving of the derision and denunciation which they have elicited in certain quarters; and we shall first direct our attention to the Darwinian doctrine of transmutation of species by "natural selection."

When Mr. Darwin published his book he told us that a close observation of nature led him to believe that new species of plants and animals were formed from previously existing ones by the "natural selection" of types, adapted to the changing character of the inorganic world, or, in other words, through the power which certain individuals possessed, by virtue of their peculiar structure, to cope with natural difficulties under which their congeners succumbed. Those privileged individuals bred and multiplied until surrounding circumstances (inorganic nature) necessitated a further modification in them, and then a fresh "natural selection" took place; or, to speak more correctly, a slow change was from these causes always proceeding in animal and plant types concurrently with the changing surface of the globe. The author adduced a large amount of precise and minute evidence in the form of changes *artificially* effected by himself and others in domesticated animals, very similar to those which, on a large scale, he regarded it to be the prerogative of nature to produce.

We may observe in passing, that this power on the part of man to bring about changes in species such as those referred to by Mr. Darwin constitutes, as it appears to us, an irrefragable proof that the larger changes produced in nature were executed by and under the direction of a wise and mighty Being, who adapted fresh forms to new conditions of existence.

And so it must have appeared to the modest and reverential author of the work, for he told his readers that the slow and unerring change which occurred in the various species of living beings adapting them to the altered condition of the globe, not only appeared to him to be a more rational and scientific view of the case than the modern interpretations of the traditional account, but that it conveyed to him a nobler conception of the Majesty of that Being who from a few simple typical forms had, in the course of long ages, evolved the beautiful and varied Creation of the present day. Mr. Darwin has never, that we are aware, advanced his hypothesis as an undoubted truth, but as an unproved theory, and has invited young and rising naturalists to test its accuracy, promising to furnish the scientific world with a large amount of additional evidence at a future time. With some unimportant exceptions this promise has not been fulfilled, owing, we regret to say, to the ill-health of the author.

Those persons who have read Mr. Darwin's book unbiassed by theological prejudice on the one hand and by scientific dogmatism on the other (for not all his followers have been so cautious and temperate as he, and there is such a thing as scientific as well as political or religious terrorism), and who have carefully considered the published opinions of other eminent observers in Zoology, Botany, and Palæontology, cannot fail to be convinced that his researches and generalizations have brought us at least one step nearer to a clear comprehension of the laws of animal and plant life, besides giving such a stimulus to natural history studies as no preceding age has witnessed. Neither can our readers fail to observe that those slow and gradual changes which Mr. Darwin attributes to the animal and vegetable kingdom, are in perfect accordance with a similar theory formerly contested with great bitterness, but now universally accepted, in regard to the Geological formations; and that the growing conviction with respect to the great antiquity of man also points in the same direction. Beyond this we feel that we have no right to go; but others think differently.

For some time after the publication of his work, Mr. Darwin's theory gained ground very rapidly, and although a little reaction has set in in certain quarters, there is at present a considerable number of scientific men of undoubted sincerity and accuracy, who are implicit believers in its correctness, regarding it as the only scientific mode of solving the problem of "species," and who, without hesitation, refer to it all past and existing biological phenomena. Now it appears to us that until a scientific theory of this nature is almost universally accepted (and not even its most zealous champions will advance such a claim for the doctrine of "natural selection"), it should be the aim of its advocates to pour into the scale every particle

of evidence they can find in its favour ; but that evidence should consist either of old and acknowledged facts, or of new discoveries. Some writers and observers do not, however, see the matter in this light, and instead of testing the accuracy of the doctrine by their discoveries or inquiring whether these afford new evidence in its favour, they at once employ it as an acknowledged standard whereby to estimate the value of their new researches, assuming their favourite theory to be the complete law of life, and with the aid of their new facts, drawing inferences in regard to the past and present condition of the globe and of its inhabitants, which would no doubt be perfectly correct, provided Mr. Darwin's theory be the whole truth. Fallacious as this method of induction may be, it is in our judgment infinitely preferable to another mode of reasoning, which discredits without inquiry all new data advanced by the believers in "natural selection," on the ground that the primary doctrine is impious, or what not; or which rejects as unsound all inferences that may be in harmony with the detested creed !

Notwithstanding the kind of "circle sailing" adopted by the first class of reasoners, we are always sure, if we accompany them, to learn something new on the voyage, and although their statements may be far from convincing, they are certain to afford us a fresh opportunity to form a correct opinion on the subject. It is not difficult to distinguish between legitimate inferences drawn from facts, and others which may be the result of feeling; and as regards the followers of Mr. Darwin, we have sufficient faith in their sincerity to believe that they would wish every communication to be carefully considered, not examined from their point of view or implicitly received like the Pope's 'Encyclical,' but that their facts and inferences should be weighed, and sifted, and criticized, and only accepted when they approve themselves to the good sense of the scientific community.

As to the accusation of materialism, another expression for atheism, to which some of the followers of Mr. Darwin have rendered themselves obnoxious (for those who profess to find any atheism in his work are not entitled to credit for candour and sincerity), it is to be deeply regretted, not only on their own account, but for the sake of Science and free inquiry. It is just as absurd in those would-be philosophers to imagine because there are accumulating indications that the processes of nature were in past ages all brought about, more or less, by secondary agencies, that therefore there is not a Creative power nor a watchful Ruler whose existence was needed to bring the universe into existence and maintain the fabric in order and harmony, as it would be for a few sapient bees to believe that because they find themselves in a comfortable hive with a convenient exit, and because flowers spring up and blossom periodically in their vicinity, therefore there is no gardener nor bee-master, and no being higher than their apiarian majesties ! We shall not gratify the love of notoriety, which usually impels such persons to publish their unreasoning dogmas, by mentioning their names, but shall dismiss them by placing them in the same category with their opposites, who can see no religion in nature because it does not accord with *their* sectarianism.

When we reflect for a moment upon the profoundly religious lessons conveyed to man's mind by a contemplation of nature in its modern aspects, we are astonished to find that there should be men assuming to be the leaders of public opinion in any civilized country, who do not perceive that the modern Temple of Science is, or should be, as divine an institution (for it is founded by the All-wise himself) as the most sacred temple that ever was raised by the hand of man in ancient or modern times. We can only account for such blindness on the assumption that these persons must have constantly burrowed in their own limited plots, and that their eyes having been thus rendered unnecessary, a kind nature has atrophied the organs, and so rendered their possessors less liable to the danger or inconvenience which might arise from any sudden influx of light.

For what purpose has man been taught the use of the telescope, if he is to regard the worlds around with unreasoning amazement? or why has he been entrusted with microscopic vision, if there are no lessons of wisdom to be learned in the invisible world? Wherefore that restless curiosity which prompts him to continue his inquiries as to his own nature and his relations with the lower animals even though the result of his investigations be repulsive to his human feelings, if not to teach him that if he would be eternally happy he must rely upon something beyond his flesh, or the material possessions secured for him by his natural superiority.

The student of nature may prosecute his observations in whatever sphere he pleases, in the fullest confidence that his employment is a sacred one. Whilst the priestly charlatan perpetuates false mysteries, appealing to bleeding saints and sweating statues, in order to check the diffusion of useful knowledge that he may with greater impunity assume the authority of the Almighty, the student of Science seeks to solve real mysteries that he may add to the store of human knowledge; he endeavours to comprehend and disinterestedly expound the laws of nature, and wield its forces for the present and future welfare of man. The reverent study of Science does not, and probably never will, initiate man into all the secrets of the Almighty, for they appear far too high for human comprehension; but it assists him in maintaining his religious conceptions on a level with his advancing knowledge in other respects, and prevents him from falling a victim to that self-sufficiency which results from any kind of success.

For, how expansive and ennobling are the thoughts inspired into the human soul, when, through the outer sense, it contemplates the universe as it appears to-day! What fresh and happy feelings such an occupation generates, and what a peaceful and contented frame of mind it leaves! And why? Because it, for the time, enables the spectator to forget *his* works and ways, in contemplating those of the Almighty; excluding from his mind all thoughts of worldly care; all the anxieties of mortal life and mortal strife.

It is indeed difficult to convey to those who have not experienced them, an adequate idea of such emotions: no creed, no formula could present them to the mind. Let the reader go forth on some clear

starlit night, and with the telescope inspect that ruddy planet which has shone so brightly in the heavens of late. With adequate enlarging and defining powers he may discern its continents, and seas, and polar snows so patent to the practised astronomical observer; and it will be no great stretch of the imagination to ponder on the nature of its denizens, for doubtless it is peopled like our own bright world.

Remembering who rules in yonder distant orb (itself a pigmy amongst giants in our solar system), he may now change the scene, and scrutinize a water-drop beneath the microscope. There he will see a multitude of forms, completely hidden from the unaided sight; some almost shapeless, others of the simplest type. And if he patiently observe this scene, he will perceive these Protozoa, these lowest forms of life, to be endowed with locomotive powers, and instincts suited to their habitat; may see them grow and multiply, and, just as in his outer world, vanquish or yield in one incessant "struggle for existence." Here, then, he finds the same presiding Power as in the distant planet, and if his little mind be capable of grasping such a thought, let him reflect that the same Being rules alike in *every* floating orb and *every* water-drop!

But we shall be told that the contemplation of these evidences of mighty power does not appeal to the emotions of the human heart, however it may serve to educate the intellect.

We would not for a moment claim for nature an all-sufficing influence for good; but even in this respect it is far from being impotent; and if there be those who can find in it no moral influence, the blame rests with them and not with nature. What a contrast is presented to us when we compare the character of man as revealed by modern society, with the Divine nature as it is read by the light of modern science!

If Man ascends from what he deems a lowly station to a higher sphere in life, the early objects of his thought and care are soon forgotten or neglected in the turmoil of the larger world in which he moves. For him the humble friends of youth or early manhood pass into another world long ere they are removed from this. Important duties press; he has no time to think of trifles nor of little men, except when these applaud *his* acts or further his great ends. He does not heed the importunity of those who wish to benefit by his promotion, not even though they were the means of raising him to his exalted station. But is it so with Him whose laws the man of science seeks to fathom and diffuse abroad? Whose power has brought the world into existence; whose forces guide the planets in their course; who slowly but unerringly works out the beautiful design; who raises up, first sentient creatures, then reflecting beings like Himself, and, watching o'er the fate of each, selects the strong and good, confers on them dominion over those who break His laws, and ministers to the happiness of all!

The Omnipotent, whose thoughts are occupied with His vast scheme, so little understood by man, cares equally for worlds illumined by His glorious suns, and for the animalcules which disport themselves so joyously within the artificial sunshine reflected from the

mirrors of our microscopes! He lacks not the applause of any; has therefore no necessity to slight the little and court favour with the great. Nor is He limited by time and space; constrained to turn His thoughts this way to-day or that to-morrow; to supervise at day-break here, at sunset yonder. We know full well that whilst He rules in Mars or on our globe, and penetrates our inmost thoughts He also sees the lowliest of His creatures, and numbers not alone the days of Man on earth, but also the few fleeting moments of the animalcule's transient existence. No object is too great, nor any too minute to elude His observation; and all created works present the impress of almighty will, omniscient wisdom, and unbounded goodness!

These are amongst the social, moral, and religious lessons taught by Modern Science, which knows no sect and recognizes no political distinctions, but whose right-minded followers seek to elevate their fellow-men without regard to creed or station and to confer the largest sum of happiness on all mankind.

ON THE APPLICATION OF SPECTRUM-ANALYSIS TO MICROSCOPICAL INVESTIGATIONS,

AND ESPECIALLY TO THE DETECTION OF BLOOD-STAINS.

By H. C. Sorby, F.R.S., &c.

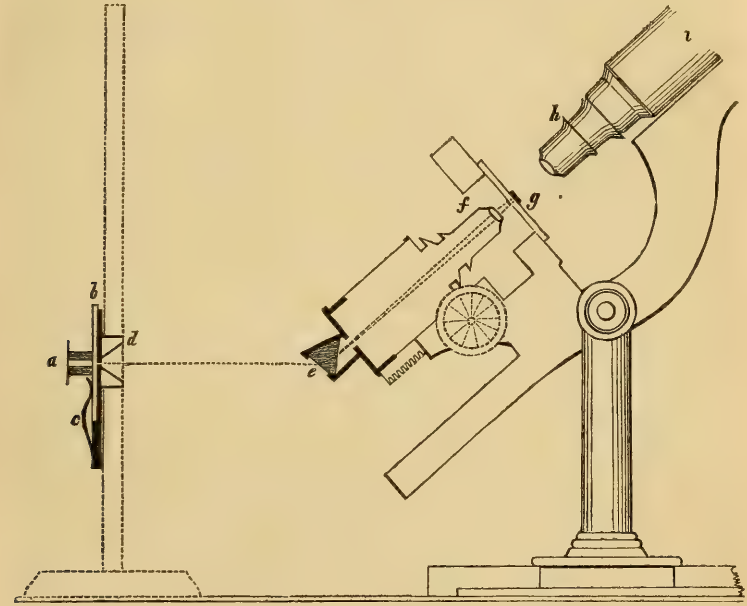
1. Introduction.—2. Description of the Instrument.—3. Spectra of Crystalline Salts, and of their Solutions.—4. Determination of the relative amount of per- and prot-oxide of Iron in Minerals.—5. Application of Polarized Light with the Spectrum.—6. Detection of Blood-Stains.—7. Conclusion.

1. *Introduction.*

Since various substances may appear to have the same colour, and yet act very differently on the spectrum, or, on the contrary, may give the same characteristic spectrum, and yet differ materially in colour, it is in all cases desirable to study them by means of the prism. As is well known, this method has been employed with remarkable success in various branches of science; but, so far as I am aware, has not hitherto been applied to microscopical inquiries. In order to accomplish this, I made a number of experiments, and at length contrived an arrangement which, so far, has answered every purpose required of it. I have also discussed the various particulars with my friends the Messrs. Beck, who intend to adapt a similar arrangement to their microscopes, and we cannot perceive how any considerable alteration could be made with advantage, except such as would be required in the case of microscopes of different construction. I shall therefore describe what I have adapted to my own, one of their large binocular instruments.

The general construction will be more readily understood by reference to the accompanying Figure 1 :—

FIG. 1.—*Spectrum Microscope.*



The only addition to the microscope itself is the prism (*e*) and its mounting, shown by the dark lines. This fits into the bottom of the movable tube carrying the achromatic condenser (*f*). Detached from the microscope is a long narrow slit, shown in section at (*b c*); and the light passing through this at (*a*) is separated by the prism (*e*), and passes on to (*g*), where the image of the slit is seen as a coloured spectrum, on looking through the microscope in the usual manner. By this arrangement we can determine the character of the light transmitted by an object placed on the stage at (*g*), or by one held in front of the slit at (*a*); and, by a little adjustment, we can compare the two spectra side by side.

2. *Description of the Instrument.*

Having thus given a general account by way of introduction, I will now describe the apparatus in detail.

The slit is made of two brass plates about six inches long and one inch broad. The lower has two strips of brass fastened at each end, between which the other plate fits, so that it may be moved up and down, and fastened by means of screws, which clamp together the upper part of the strips. The edges of the plates, thus brought toge-

ther, are made quite straight and bevelled, so that by putting a small piece of thin writing paper at each end, pressing down the upper plate, and fixing it with the screws, an opening is left between the plates five inches long and about $\frac{1}{400}$th of an inch wide. The lower plate carries a small arm, fitting into a tube attached to a stand (shown by the dotted lines), such as is employed to hold a bull's-eye condenser, so that the slit is always horizontal, and that we may vary its height from the bottom of the stand, and the inclination of the face of the plates. Then, since it is often requisite to hold different sorts of objects in front of the slit, a piece of brass, to act as a stop, carrying a spring, is fixed on one side, as shown at (*c*), so that a square piece of glass can be held in the same position, or moved up and down directly in front of the slit. In the figure the plates of brass are shown by the black portion (*b c*), the glass by the unshaded part on the left side below (*b*), whilst the shaded part at *a* represents a small narrow tube into which any liquid may be put for examination. Large crystals or other objects, mounted on plates of glass, may also be held in the same manner. In some cases it is desirable to examine solutions held in test-tubes. For this purpose two pieces of wood are fixed on the other side of the brass plates, shown in section at (*d*), extending the whole length, and even projecting beyond them at each end. They are made in the V form shown in the figure, so that, whether the tube be small or larger, its centre may be directly in front of the slit; and wood is better than brass when it is desirable to examine hot solutions. Towards each end is a spring, so that two tubes may be held, and the spectra of the liquids they contain compared. Of course all parts of these fittings must be a good, dead black. I have covered the brass with black silk, which cannot be scratched by the glasses, fastening it down with liquid Indian rubber.

Since it is often desirable to have a very narrow spectrum, a prism of crown-glass is better than one of flint-glass; and, when a broader spectrum is required, it can be readily obtained by using a condenser of longer, or an object-glass of shorter, focal length. The prism should be fixed in the position shown at *e*, so that the light may enter at *a e*, and pass off at *e g*, at about equal angles. With crown-glass the front face (*e*) should therefore be inclined at about 10° to the axis of the microscope. The prism might be fitted just within the tube of the condenser; but I have fixed it as shown, so that a large Nicol's prism may be inserted above it, to be used as described in the sequel. For some purposes day-light must be used, especially when it is desirable to have the blue end of the spectrum well seen; but very often lamp-light is better, for Fraunhofer's lines do not interfere with the observations, the quality of the light is more uniform, and, the lamp being placed at about the same height as the prism, the requisite inclination of the microscope is then just that which is most convenient for the observer. In using a lamp, a large bull's-eye condenser should be placed between it and the slit, so as to give a broad or narrower image, according to circumstances; and by throwing the image of the edge of the flame on the object, a larger amount of blue

light may be obtained, if that be requisite. With day-light the condenser is not necessary, but the slit must usually be raised, the microscope inclined at a less angle, and a screen of blackened cardboard, with a suitable opening, placed in front of the slit, extending from the table to some distance above *b*, so as to shut out extraneous light. Since the uniform blackness of the field is often impaired by seeing the reflection of various parts of the microscope from the upper surface of the condenser, it is in all cases desirable to have a blackened tube fixed over the end of the object-glass, extending down nearly to the focus.

When all is properly arranged, the narrow beam of light passing through the slit at *a*, gives a spectrum at the focus of the achromatic condenser (*f*), which is so adjusted that the focus may coincide with any object placed on the stage at *g*. Both are magnified by the object-glass (*h*), and seen on looking down the microscope; the spectrum extending horizontally across the field, having the red at the top and the blue and violet at the bottom. In my description it will therefore often be convenient to speak of the red as the upper, and the blue as the lower, end of the spectrum. The breadth depends on the focal length of the condenser and object-glass, and also on the distance of the slit from the prism, and the thickness and refracting power of any object placed on the stage at *g*. By using suitable lenses, we may readily obtain a spectrum $\frac{1}{1000}$th of an inch in width, so that the whole may be seen through a crystal of that minute size, or we may make the spectrum spread over the whole field of the microscope. However, it is usually much better not to have the condenser and object-glass of short focal length, since there is then more light, the spectrum is of better quality, and the different portions in better focus. A condenser of $\frac{2}{3}$rds of an inch focal length combined with an object-glass of $1\frac{1}{2}$, or a $1\frac{1}{2}$ combined with a $2\frac{1}{2}$, answer very well.

By using a micrometer in the eyepiece, the position of any dark or bright band in the spectrum can be readily measured with sufficient accuracy. I find it very convenient to use such powers, and fix the slit at such a distance that the whole spectrum measures 12 divisions of a micrometer, having lines $\frac{1}{200}$th of an inch apart. In that case the sodium line is as nearly as need be 3 from the top and 9 from the bottom. The slit can be easily kept at the proper distance by means of a strip of wood resting above the prism and on the slit. To get a correct datum with lamp-light, I have a platinum wire with a loop holding common salt, so arranged that it can be turned into the flame, and the sodium line seen as a bright yellow band in the spectrum. After making one of the chief lines of the micrometer coincide with this, the wire can be turned out of the flame, and the position of any part of the spectrum measured. If day-light be employed, and a good object-glass used for the condenser, Fraunhofer's principal lines can be readily seen, and D may be made use of as a datum in a similar manner.

I trust I have now made the general arrangements sufficiently intelligible, and will proceed to describe some of the objects to which

the instrument may be applied. Of course, a number of these could be studied by means of an ordinary spectroscope; but then, not only are they in many cases so intimately connected with microscopical inquiries, that a microscope as such can be most usefully employed; but moreover, to say nothing about the advantage of making one instrument serve instead of two, with the very simple additions I have described, a spectrum microscope answers in some respects better than an ordinary spectroscope. In the construction of that instrument the aim is to have a wide spectrum, so as to distinctly separate well-marked lines, whereas the absorption bands seen in the spectra of many coloured bodies are often so faint, that they are quite invisible when spread out in a wide spectrum, though readily seen when narrow and more concentrated. This being the aim in constructing the spectrum microscope, it is necessarily inferior to an ordinary spectroscope when applied to the study of the lines in coloured flames, though, at the same time, it is by no means to be despised for rough experiments of that kind. The microscope should then be made horizontal, and the prism and slit vertical, so that the flame may pass straight in front for some distance.

3. *Spectra of Crystalline Salts and of their Solutions.*

The action of various coloured solutions and crystals has been already studied by many authors; but, so far as I am aware, not much attention has been directed to the relation existing between the light transmitted by solid or powdered crystals and by their solutions, in order to assist in arriving at a definite conclusion as to their condition when dissolved. This subject can be worked out in a very satisfactory manner by means of the instrument I have described; for the spectra of solutions and of very minute crystals can be compared side by side, and very slight differences easily detected. I have already collected a large amount of material, and, at first, intended to describe many of the facts in this paper, but I find that so many still remain to be determined, and the conclusions to which they lead are so intimately connected with a general theory of the connection between chemical and mechanical force, that they ought rather to form part of a memoir on that subject. I shall therefore now chiefly confine myself to a description of the requisite apparatus and the manner in which it may be used.

Highly-coloured solutions may be very conveniently kept in tubes about 3 inches long and $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in diameter, made with one end flat and the other drawn out to a point, which can be sealed up after having introduced the solution by means of an air-pump. These are put lengthwise in front of the slit, as already described; and when all is properly arranged, the spectrum of the solution is seen extending over half the field of the microscope, divided from the natural spectrum by a narrow dark band, due to the flat end of the tube. I have also often mounted solutions in cells made from thick glass tube, similar to those used to mount objects in liquid, and have examined very faintly-coloured solutions in tubes varying in length up to 20

inches or more, closed at the ends with plate glass. These answer very well, and give a much longer spectrum than might be expected, on account of the light being reflected down the sides of the tube.

On placing a crystal on the stage of the microscope as at *g* in the figure, and the tube containing the solution in front of the slit as at *a*, it is easy so to arrange the focus of the condenser and the position of the tube and of the crystal, that the spectra of the salt and of the solution may be seen side by side, or with a narrow band of natural spectrum between them.

Since the width of the spectrum is modified by the thickness and refractive power of the substance placed between the condenser and object-glass, it is desirable to mount the crystal in Canada balsam, or else to fix a piece of glass of the same thickness alongside of it, otherwise the spectra seen through the crystal and outside it are not at the same focus or of the same width. It is also best to use a condenser and object-glass of as long focal lengths as circumstances will permit, raising, if it be necessary, the glass on which the crystal is mounted by means of a small stand fitting on the stage of the microscope.

Proceeding in this manner, I find that, as a general rule, crystalline salts have the same action on the spectrum as an equal amount dissolved in water; but there are many interesting exceptions due to special optical properties of the crystals, to the dissolved salt being probably combined with a different amount of water, or, in some cases, to isomeric changes. At all events, the facts throw much light on the state in which substances exist when dissolved.

4. *Determination of the relative amount of Per- and Prot- oxide of Iron in Minerals.*

When I first thought of applying a prism to the microscope, one of my chief objects was to employ it in studying the minerals seen in thin sections of rocks. So far, however, I have only been able to apply it to determine whether the iron exists as protoxide or peroxide, and, employing polarized light for the spectrum, to learn certain facts connected with the double refractive power of the minerals.

The action of persalts of iron depends partly on the amount of combined water. When anhydrous, the point of maximum transparency is situated about halfway between D and the extreme red, so that when the blue end of the spectrum is cut off to D, all the red is still transmitted. When hydrated, this maximum point is farther and farther from the red end, according to the amount of combined water. For example, in pentahydrated perchloride of iron, the maximum point is $\frac{2}{3}$ the distance from it towards D, whilst in the dodecahydrated it is situated near D, and the crystals are therefore yellow, but melt when heated into a solution of the orange-red pentahydrated. Very dilute solutions of the persalts absorb the blue end of the spectrum, and, on increasing the strength, they absorb more and more of the green. On the contrary, a strong solution of protochloride a foot

thick entirely cuts off the red end of the spectrum to D, so that, on placing in front of the tube one containing a strong solution of the perchloride, no light whatever passes. Mixing the two solutions produces no change, and the opacity is so complete that direct sun-light does not penetrate through it. We may thus readily explain why the protoxide combined with peroxide gives a black oxide; for one cuts off all the rays which the other transmits. Taking 12 as the width of the entire spectrum, a foot thick of protochloride also cuts off the blue end up to 2 below D, and only transmits bright green rays. On reducing the thickness to about 4 inches, one-half of the spectrum from the red end to D is cut off, but the blues and violet are slightly transmitted; and when the thickness is an inch or so, the whole of the blue end readily passes, though the extreme dull red is cut off for about $\frac{1}{4}$th of the distance to D. The crystallized salt acts in the same manner. So far as I have been able to ascertain, similar principles apply to the oxides of iron when combined with silica. Different kinds of bottle-glass show this very well. Since the intensity of the colouring due to a given amount of oxide may vary, it is impossible to do more than form an approximate conclusion as to the relative action of the two oxides in producing the colour; and it is in this sense that I shall speak of one or other preponderating. However, I think we may deduce the following conclusions:—If a mineral cuts off the blue end of the spectrum nearly to D, but transmits the red up to the extreme limit, there can be little or no water or protoxide present; whilst, on the contrary, if it contain little or no combined water, and be sufficiently coloured to cut off the red end halfway to D, and yet transmits all the blue, there must be very little peroxide present. If it cuts off all the red end to D, and yet transmits the green part of the spectrum, there must be relatively more protoxide than peroxide. If the blue end is cut off to near D, and also a considerable part of the red, so that only a narrow band of light is transmitted above and just below D, unless much water be present, there must be a good deal of both peroxide and protoxide; whereas, if there is only a slight action at both ends of the spectrum, there cannot be much of either. For example (assuming that the colour is chiefly due to the oxides of iron), the red mica in a lava from the Lower Eifel transmits the extreme red, but cuts off half the spectrum from the blue end, and therefore nearly all the iron must exist as peroxide. Augite in a lava of Vesuvius, which has been melted *in situ*, whilst the surrounding rock remained nearly solid, cuts off a little of the extreme red and also half the entire spectrum from the blue end, and hence contains more per- than prot- oxide. Bright green chlorite in slate from Keswick cuts off about $\frac{1}{4}$ of the distance to D from the red end, and also $\frac{1}{4}$ of the whole spectrum at the blue end, and therefore contains relatively less per- than prot- oxide. Such facts might often be good checks on the results obtained by analysis, even if material enough for that purpose could be procured.

5. *Application of Polarized Light with the Spectrum.*

In employing polarized light with the spectrum, it is requisite to insert a Nicol's prism between the prism and the achromatic condenser, and to use another Nicol's prism as analyzer, over the eyepiece. If then, the polarizer and analyzer being so placed as to give a dark field, a plate of selenite or other doubly refracting crystal be so arranged on the stage of the microscope as to bring its maximum power of depolarization into play, we see a spectrum of the usual colours, crossed at equal intervals by black interference bands, shaded off quickly on each side to the neighbouring colour. The number of these bands depends on the thickness of the plate. Thus, if, when examined with an ordinary polariscope, the colours are of the second order, there is one dark band in the spectrum; if of the sixth order, three bands; and if of higher orders, still more. But, as is well known, high orders are very faint reds and greens, and still higher mere white, so that a great difference in thickness makes no change in colour. When, however, examined with the spectrum and polarized light, the dark bands are very visible, and increase in number with the thickness of the selenite, until so numerous as to be undistinguishable. If, instead of comparing different thicknesses of the same mineral, we compare much the same thickness of different minerals, of course making allowance for difference in the position of the principal axis of the fragments, the number of the bands indicates a difference in the power of double refraction, and therefore this character becomes useful in studying some branches of microscopic mineralogy. For example, microscopic fragments of quartz, topaz, and calcite, of much the same size, show respectively a very few, a moderate number, and very many bands; and in studying thin sections of rocks, two minerals which do not show any other characteristic difference, might be distinguished by this means.

6. *Detection of Blood-Stains.*

Passing from these almost purely scientific questions, I will now describe the application of the spectrum-microscope to a very practical subject, *viz.* the detection of blood-stains in criminal inquiries. The optical properties of blood have been described by Hoppe,* and in still greater detail by Professor Stokes.† Hoppe suggested that the peculiar and characteristic spectrum of fresh blood might be employed as a test, but the plan he proposed was to moisten the blood-stain with water and examine it direct; which of course could not be done, if it were on a highly-coloured fabric. Professor Stokes also suggested that the spectrum of deoxidized hæmatin might be employed for the purpose, but did not further develop the subject, being evidently desirous to investigate it chiefly in relation to chemistry, optics, and physiology. However, in considering the question, I soon became convinced that it deserved a most careful study with special

* 'Virchow's Archiv.' vol. xxiii. (1862) 446.
† 'Proceedings of R. S.' xiii. (1864) 355.

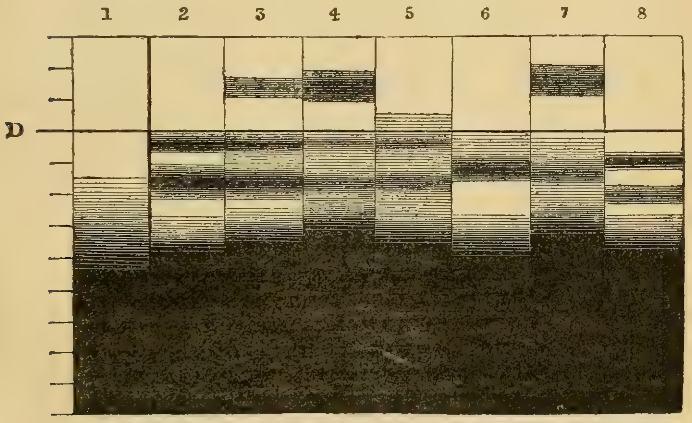
reference to the detection of minute traces of blood in criminal investigations, and therefore have directed a great amount of attention to that point alone. Such inquiries almost necessarily fall into the hands of a microscopist; and, as I shall show, the apparatus I have described will enable anyone to detect with certainty most marvelously minute traces of blood, when the usual methods would entirely fail. That merely chemical tests are generally suspicious, and often not to be trusted at all, is freely admitted by my friend Dr. Allan, who has had much experience in such inquiries; and, of course, if the red globules have been destroyed, the microscope alone is of little or no use. In such cases the method I now propose comes to our aid, and enables us to detect as small a quantity as $\frac{1}{1000}$th of a grain of the colouring matter of blood, left on a fabric from which apparently all traces have been washed, or which only shows a slight discoloration. If all has been washed out its detection is no longer possible; for it is this colouring-matter itself, and not any action on the material, that proves the former presence of blood.

Since in studying the spectra of blood, it is important to be able to operate on small quantities, I have employed cells, cut from a barometer tube, having an external diameter of about $\frac{1}{2}$ inch, an internal diameter of $\frac{1}{8}$, and $\frac{1}{2}$ inch long, slightly polished at both ends. These may be fixed with Canada balsam in the centre of pieces of glass about 1·6 square, or what is still better, in the centre of the longer side of triangular pieces, formed by cutting such squares along a diagonal, so that two may be placed side by side in front of the slit, and the spectra of two solutions compared together at one view. Liquids can be readily introduced into such cells by means of a moderately stout platinum wire; and, when rather more than full, so that a little spreads over the top of the cell, a piece of thin glass can be easily put on without inclosing any bubble, and the surplus removed with blotting-paper. Capillary attraction keeps the glass on, and evaporation takes place so slowly, that everything remains for a considerable time in a proper condition; and, if desirable, the glass may be fixed on by means of gold-size, and the solution kept for weeks. Placing such a cell in front of the slit, as at *a* in Fig. 1, the light passes through the thin glass at the top, through the column of liquid and the thick glass at the bottom, and then through the narrow slit to the prism. Cells of less diameter than $\frac{1}{8}$ of an inch might be used, but it is difficult to fill and empty them. Even when $\frac{1}{8}$ in diameter, if it be requisite to transfer the solution to a watch-glass, it is well to have a piece of such tube as is used for spirit-thermometers, drawn out at one end and bent at a right angle, so that it may be introduced to the top of the cell, and the liquid removed by blowing down the tube.

The exact position of the dark absorption-bands in the spectra obtained from blood being a very important character, it is necessary to make use of the micrometer; and I have found that for this purpose it is well to arrange the instrument so that the width of the entire spectrum is about 12, as shown by the divisions on the left hand side of Fig. 2. I shall adopt this method of measurement in all

my descriptions. Gas-lamp light is, if anything, better than daylight, because the line C of Fraunhofer interferes with the correct determination of some facts. Turning a wire holding common salt into the flame, the bright yellow sodium line is seen; and one of the principal lines of the micrometer having been made to bisect it, the wire is turned out of the flame and the measurements made.

FIG. 2.—*Blood Spectra.*



Since human life might depend on the accurate determination of the facts, I shall describe all the characteristic peculiarities of the spectra, so as to avoid, as far as possible, any serious mistake. If a piece of linen $\frac{1}{8}$ or $\frac{1}{10}$th of an inch square, soaked with blood, and quite recently dried in pure air, be digested in a few drops of water in a watch-glass, it yields a solution, which, when introduced into one of the cells just described, produces a spectrum like No. 2 in Fig. 2. The blue end is quite absorbed, and so are two bands in the green, but the whole of the red end is transmitted. When the solution is stronger, the absorbed portion of the spectrum increases upwards, and the dark bands in the green become broader, until the whole of the light below D is absorbed, and merely a bright red remains above it. If examined when the yellow sodium line is present a narrow dark band is seen just above it, even when the spectrum is like No. 2, and shows no such dark band in that position with the natural light. On diluting the solution the bands in the green become more and more narrow and faint, but do not disappear until it is so dilute that the blue end of the spectrum is transmitted without sensible alteration. Since the width of the bands varies with the strength of the solution, the position of their edges is not constant, though that of their centre is nearly so, and will be given in the following descriptions. However, it is somewhat difficult to determine it with great accuracy, on account of the gradual shading off on each side, which of course can be only imperfectly represented by a woodcut. Taking the whole

spectrum at 12, the centre of the upper band is at $\frac{1}{3}$ or ·4; of the lower, $1\frac{2}{3}$; and of the green between them 1. The upper band has a sharper outline, and, when so much blood is present as to cut off about $\frac{1}{2}$ of the spectrum, its width is about $\frac{2}{5}$ that of the lower, as shown by No. 2. As a good example of an entirely different spectrum, given by a solution of very similar colour, I refer to No. 1, which represents that of a dilute solution of perchloride of iron to which a little sulphocyanide of potassium has been added. In its case the blue end of the spectrum is more and more absorbed, according to the strength of the solution, but no narrow, dark bands are formed in any part. The spectra of many red colouring-matters have this character, and therefore could not possibly be confounded with blood. Cochineal does indeed yield an absorption band in the same position as the lower in fresh blood, but it is extremely faint, and there is none where the upper band occurs. A second does exist, but it is $3\frac{1}{2}$ below D, and is seen only when the solution is so dilute that the blue part of the spectrum is freely transmitted. On adding ammonia to the solution of cochineal, two absorption bands are produced, in such a position that without care they might be confounded with those of blood; but the upper is decidedly broader than the lower, whilst it is the reverse in blood; and its centre is also lower, being $\frac{1}{2}$ and not $\frac{1}{3}$ from D. A solution of cudbear in dilute alcohol also yields two very faint bands in much the same place as those in fresh blood, but on adding ammonia the band at $\frac{1}{2}$ becomes very dark and distinct, and the lower band vanishes. The addition of ammonia to a solution of fresh blood produces no such changes.

The gravy of roasted meat gives different spectra according to circumstances. The red liquid, which comes from it when undercooked, is merely a solution of cruorine, and gives the same spectrum as fresh blood; but the usual light or darker brown liquid sometimes gives a dark and sharply-defined absorption-band at about 1·4 below D, and suddenly cuts off all the rays below $2\frac{1}{4}$. The addition of ammonia causes a precipitate, but leaves an obscure band in the same situation. Citric acid removes the band entirely, but ammonia in excess restores it without causing a precipitate; and the addition of protosulphate of iron produces no change. When dried and strongly heated, the colour becomes darker, and it merely cuts off more or less of the blue end of the spectrum, as in No. 1, without there being any detached absorption-bands. Probably this is why dark-coloured gravy often has that character. Thus, though, as far as tests are concerned, the chemical composition is almost identical with that of blood, the optical characters and the manner in which gravy behaves with reagents, suffice to distinguish it; unless it be from meat so extremely underdone, that it is in fact merely more or less modified blood.

If blood be dried on white linen, and exposed to the air, the bright scarlet colour changes by degrees into brown. This fact must be well known, but so far as I am aware, has not been studied optically or chemically. When the change has not proceeded far, the blood yields a spectrum like that shown by No. 3. The two well-marked bands in the green are much the same as in fresh blood; but there is

also one in the red, having its centre at $1\frac{1}{3}$ above D; and therefore a trifle lower than Fraunhofer's line C. The intensity of this band shows the amount of change; and, when it has become complete, the spectrum is very different from that of fresh blood, as shown by No. 4. In this change the bands below D in the green become more and more faint, especially the upper, which finally is only just visible. A larger quantity of blood is required to show spectrum No. 4, than to show No. 2; and if the solution be strong enough, only a dirty-brown red light is transmitted, with a dark band in its centre. When kept under similar conditions, the extent of this change serves to show the length of time since the blood was fresh; and at one time I hoped that by this means it would be possible to determine the time with some confidence, which would often have been very valuable in criminal inquiries. In some cases it might, indeed, be made available, but in and near a town it could not be relied on at all. When sealed up in a glass tube in a perfectly dry state on linen, it would give such a spectrum as No. 3, after having been kept for two or three months; but when sealed up wet, there is apparently little or no such change. It thus appears that it partly depends on being dry, but will take place independently of being exposed to atmospheric influences. These, however, greatly accelerate it. Exposed to the air on Burbage moor, six miles from Sheffield, and about 1,000 feet higher, one or two miles from any house, the change took place more rapidly, so that the spectrum was nearly as No. 3, after a week or so; whereas in the centre of the town as much action took place in a few hours. Kept in the house, the rate of change varies very much accordingly as gas is burned in the room or not; and, when I had ascertained this fact, I concluded that it must be due either to carbonic or sulphurous acid. I therefore kept some in a flask with carbonic acid, without being able to perceive any marked effect, whereas sulphurous acid disseminated in a large quantity of air, turned it brown very soon, and caused the spectrum to change from No. 2 to Nos. 3 and 4; but, if much acid be present, it produces a more complete decomposition, and the absorption-bands are not so distinctly visible. It appears, therefore, that this change in the colouring-matter takes place in dry blood, whether exposed to the air or not, but is greatly accelerated by free exposure to fresh air, and especially by the presence of the sulphurous acid produced by the combustion of coal or gas. Light appears to have little or no influence. Carrying out the nomenclature of Professor Stokes,* I suggest that the brown colouring matter thus produced, should be called "brown cruorine." Though it is apparently dissolved by water, and yields a clear solution, yet it is doubtful whether it is soluble in the most strict sense of that term. Close-grained filtering paper removes a great part, and on standing for some time the finer particles collect and subside. It is also difficult to dissolve it from linen, or similar material without repeatedly moistening and squeezing it with forceps, so as to detach the minute particles, some of which remain quite firmly attached; and

* 'Proceed. R. S.' xiii. 355.

on the whole it is an excellent example of a connecting link between substances that are really dissolved by water, and those which can only be disseminated through it in comparatively large particles.

If ammonia be added to a solution which would give such a spectrum as No. 4, we obtain one like No. 5. The band in the red disappears, those in the green become far more distinct, and the spectrum is similar to that of fresh blood, only the bands are more faint, and it is slightly shaded up to ½ above D.

If a small quantity of a strong solution of this brown cruorine be placed on a piece of glass, and allowed to evaporate slowly, the greater part collects as a dry film round the outside of the drop; and, when examined on the stage of the microscope, it yields a spectrum like 4 or 5, accordingly as it is damp or quite dry. If dry, the spectrum is very similar to that of fresh blood, only the absorption-bands are less distinct; but, when breathed on, so that it may again become damp, the dark band in the red makes its appearance, and those in the green become more faint. These changes take place over and over again, though they gradually cease after some days; and hence it would appear that the dark band in the red depends on the presence of moisture, and may be due to the formation of some hydrous compound, decomposed on drying. The scarlet cruorine of fresh blood, treated in the same manner, exhibits no such changes, and gives the same spectrum as its solution in water.

Drying solutions of blood on glass in this manner gives very satisfactory results, and specimens so prepared may be kept in that state, or under thin glass fixed down with Canada balsam, without there being any sensible alteration after above half-a-year. The solution may be placed on a small square of thin glass till it has evaporated and become reduced to a drop or so, and then, having redissolved the dry part in the liquid, it may be allowed to run off at one corner to the glass on which it is to be kept, leaving the minute foreign fragments behind. If, however, the mordants used in dying the fabric have changed the blood to hæmatin, the results are not satisfactory. A solution of fresh blood mounted in a cell still gives the characteristic spectrum after some months, though more faintly than at first. Brown cruorine soon forms a deposit, and loses its character when thus kept.

Professor Stokes has described the change produced by the action of deoxidizing agents on fresh blood. Whether the cruorine be fresh and scarlet, or have been more or less converted into the brown modification, if citrate of ammonia be added to an alkaline solution, so as to prevent the precipitation of oxide of iron, and then, having introduced it into a cell, if a small piece of crystallized protosulphate of iron be added, and broken up and stirred till dissolved with a platinum wire flattened at one end and bent at right angles so as to form a sort of little hoe, we obtain the spectrum No. 6. There is one well-marked absorption-band, the centre of which is 1⅛ below D, and a general shading upwards as far as D. Hence it is clear that the change from scarlet to brown cruorine is not of such a nature as to prevent both from yielding the same spectrum when deoxidized; or,

as described just below, from most readily passing into hæmatin, when acted on by a weak acid. So far I have been unable to decide whether the difference consists in brown cruorine containing more oxygen or water, or in its being only an isomeric modification of the scarlet. However, since such a powerful oxidizing agent as permanganate of potash does not produce it, and since it is not formed in solution or when damp, the latter supposition appears to me to be the most probable, unless indeed it contains less water.

Professor Stokes has shown that weak acids convert cruorine into hæmatin,* and has described the spectrum produced by it in its natural state, and when alkaline and deoxidized. On adding acetic acid to a solution of either scarlet or brown cruorine, a spectrum is obtained like that shown by No. 7. There is a well-marked absorption-band in the red, the centre being situated at $1\frac{1}{2}$ above D, and therefore rather higher than that in the case of brown cruorine, and very nearly in the position of Fraunhofer's line C. There is also another at about 1·4 below D, and perhaps a third still lower, which is only seen when the solution is more dilute, and even then so obscurely that its existence appears doubtful. When dried on glass the band in the red does not disappear; and when the solution is strong, ammonia causes a precipitate, as though hæmatin were much less soluble in ammonia than either scarlet or brown cruorine. However, the solution being somewhat dilute, using about $\frac{1}{3}$rd or $\frac{1}{4}$th of a grain of citric acid to prevent the subsequent precipitation of oxide of iron, adding ammonia in decided excess, and introducing the whole into a cell; if about $\frac{1}{20}$th or $\frac{1}{30}$th of a grain of crystallized protosulphate of iron be dissolved in the solution, we obtain the very well-defined spectrum of deoxidized hæmatin shown by No. 8. The centre of the upper band is $\frac{7}{8}$ below D, and of the lower at 2. The upper is about $\frac{1}{2}$ wide, very dark, and sharply defined; the lower nearly the same width, but much more faint. Neither is much shaded at the edges, and both vary more in darkness than in width, on increasing or decreasing the strength of the solution or the length of the cell in which it is examined. When concentrated, and in a tube $\frac{1}{2}$ an inch long, the width of the bands is much as shown, but the shaded part is darker. In a tube $\frac{1}{8}$th of an inch in diameter, a spectrum as distinct as No. 8 is given by $\frac{1}{100}$th of a grain of liquid blood, making on thin linen a spot about $\frac{1}{10}$th of an inch in diameter; and such a minute quantity will show the bands faintly, yet distinctly, that $\frac{1}{1000}$th of a grain of liquid blood would be quite enough to furnish us with unmistakable evidence of its presence, if some little care and trouble were taken over the experiment, and the solution examined in a cell not more than $\frac{1}{10}$th of an inch in diameter.

It thus appears that in various conditions blood yields no less than eight very different spectra. At all events, we can most readily get four or five, so characteristic, that with proper care there could be no fear of confounding it with any other substance that I have hitherto examined, and probably not with any in existence. However, in all

* 'Proceed. R. S.' xiii. 357.

important investigations, it would be advisable to examine the spectra of any substance likely to be present. I would also specially insist on the importance of carefully attending to the exact position and character of the absorption-bands; and before anyone gave evidence on such a subject, that he should make himself practically familiar with the facts I have described.

In applying this method to the detection of blood-stains on various articles of clothing, it is requisite to ascertain the effect of the different materials, dyes, and mordants. I have for this purpose made a great many experiments, and yet probably much remains to be learned. As a general rule, the dyes exercise little or no prejudicial influence; but when alum has been used as a mordant, it produces an effect which might easily mislead. Hitherto I have not been able to overcome the effect of the tannin in different sorts of leather. They precipitate the colouring-matter of the blood, and no spectra can be obtained. If, indeed, the blood can be scraped off from the surface without any considerable amount of leather, it can be detected as usual; but, if it had been sponged or washed, probably no trace whatever could be detected. The same applies in the case of those woods, which, like oak, contain tannic acid. Vegetable soil, when its amount is large in proportion to that of the blood, also precipitates the colouring-matter in an insoluble form; but, where the relative amount is small, as on dirty clothes, it does not sensibly interfere with the test, though it tends to impair its delicacy.

When scarlet or brown cruorine is acted on by a solution of alum, it is converted into hæmatin. If it has been used as a mordant, sometimes a portion remains in such a condition as to produce this change in blood-stains; and, moreover, the alumina may combine with the colouring-matter of the blood, and make it insoluble. In such cases it is impossible to obtain the spectrum of either scarlet or brown cruorine; but if a piece of cloth, mordanted in this manner, marked with blood, be digested in a few drops of water in a watch-glass, and repeatedly squeezed with forceps, a turbid solution is obtained, which, treated with citric acid, filtered, rendered alkaline with ammonia, and deoxidized with protosulphate of iron, shows quite well the spectrum of deoxidized hæmatin No. 8.

In a few cases the colouring-matter of the dye is slightly dissolved by water. I have especially noticed this in the case of black printed calico; and if much of such material, containing very little blood, be digested in water, the dye may cut off the characteristic part of the spectrum. Care should therefore be taken not to use any of the material not well marked with blood, and to have the solution so dilute that the dye may not cut off the green rays.

Almost everyone must have noticed the fact that, when a blood-stain on white linen or calico has been exposed to pure air for only a short time, it can be almost entirely dissolved out by water; but, if dried and exposed for some time, the imperfectly soluble brown cruorine cannot be entirely removed, and leaves a brown stain, which, though readily seen on white material, might be scarcely visible on coloured or black. However, on digesting the suspected portion in a

few drops of water with citric acid in a watch-glass, and proceeding as already described, a most unmistakable spectrum like No. 8 may be obtained, even when the stain is only half-an-inch square, and scarcely visible. In attempting to remove a blood-stain from cloth by sponging, on the first application of the water a solution of blood would be formed, and run into the surrounding cloth by capillary attraction. Hence, though the stain may appear to have been removed, the cloth round about might, and probably would, retain abundance of the colouring matter, which could be dissolved out. Any suspicious marks that might be due to such treatment should therefore be examined with care. Of course, in such cases the microscope alone would be of no avail, and mere chemical tests could not be relied on, and thus the spectrum method becomes especially useful. Specimens of this character having been placed in the hands of some of the first authorities in such inquiries, they said that neither they nor anyone else could make out anything from them; nor would they believe that I could, though the amount of blood was such that in a few minutes I could have shown such a spectrum as No. 8, and have been in a position to give evidence with great confidence.

When soap is present it causes a precipitate; but this is quite soluble in plenty of ammonia, and does not prevent our seeing the spectrum No. 8. Boiling water, instead of facilitating the removal of blood, makes it more fixed, by coagulating the albumen. If the blood be dried on glass, the colour is changed to a brownish red, and it gives a spectrum like No. 5, whether dry or damp. When dissolved by citric acid, it yields hæmatin, and readily gives spectrum No. 8.

In some cases foreign matters, or the mordants, make the solution so turbid that it is difficult to see the spectrum to advantage. If we wish to observe the spectrum of blood in its natural state, or as it becomes by mere exposure to the atmosphere, it is better not to filter, but to allow the solution to stand in the cell in front of the slit, until it has become sufficiently clear; because filtering would probably remove much of the colouring-matter of the blood. However, in some varieties of brown cloth the mordants give rise to such a turbid solution, that it is very difficult to see the spectrum in a satisfactory manner. Citric acid should therefore be added to make the colouring-matter more completely soluble, and the liquid filtered. For such small quantities a blotting-paper filter $\frac{3}{4}$ of an inch in diameter should be used. It can be conveniently supported on a platinum wire bent at one end into a ring, and made to slide up and down a small wire for a support; and if the bottom of the filter touch the cell or watch-glass, though the liquid may pass through slowly, the final result is far more satisfactory. After the acid solution has passed, it is well to add the ammonia by allowing it also to go through the filter, to carry away any colouring-matter, soluble in that reagent, that might remain on the filter.

Though in actual practice many other facts may turn up to render special modifications necessary, yet the following is the method I should adopt in examining a mark or stain supposed to be due to blood, assuming that only a small quantity was at my disposal. I

should first cut off a portion of the material where *not* marked, and digest it in four or five drops of water in a watch-glass, squeezing it with forceps, and moistening it over and over again. If the solution became coloured, I should introduce it into a cell and determine the character of the spectrum, both in its natural state, and after having been acted on by the different reagents already mentioned. I should then add a very little blood to a few drops of water, and digest in that solution a small piece of the material, so as to make out whether it contained anything that acts on the colouring matter of blood. Having satisfied myself on these points, I should cut off a small bit of the stained portion, using from $\frac{1}{10}$th to $\frac{1}{4}$th of an inch square, according to the character of the mark, and the amount of material at my disposal, and digest it in three or four drops of water in a watch-glass. If the solution became well coloured, I should not squeeze the material so much as to detach many minute particles of foreign matter; but if there appeared to be very little colour present, I should dissolve from it all I could, and take care to waste as little solution as possible, and have no more than would properly fill the cell. Transferring the solution to a cell about $\frac{1}{2}$ inch long and $\frac{1}{8}$th inch in diameter, and having placed it horizontally in front of the slit, and left it a short time, so that the minute particles of foreign matter might settle to the lower side of the tube, I should examine the spectrum, and carefully note the exact position and general characters of the absorption-bands, if the solution were too strong, diluting it until they were well seen. If the spectrum were like No. 2, I should feel nearly sure that the mark was due to blood; and, if it had been kept dry in a town, I should also conclude that it was nearly fresh. If it were as No. 4, I should feel inclined to believe that it had been exposed to the air for some time; but, unfortunately, the character of the atmosphere makes so much difference that no rule can be given. If, however, in any particular instance a knowledge of the length of time that had elapsed since the blood was fresh were of importance, a more definite opinion might be formed after a few days' experiment with fresh blood, keeping it, if possible, under the same conditions, and using the same material as in the case in question. If the spectrum obtained was like No. 4, I should add ammonia in excess, so as to obtain one like No. 5, and afterwards add citric acid in excess, so as to see spectrum No. 7. Then adding excess of ammonia and a small quantity of protosulphate of iron, stirring it to dissolve all the oxide, but not so much as to peroxidize and make the solution so yellow that it would not transmit the green, the spectrum No. 8 would be well seen, even when a very small quantity of blood had been present. If plenty of material remained, I should take another portion, dissolve the blood from it, add citrate of ammonia, taking great care that the solution was never acid, and then deoxidize by means of a little protosulphate of iron, so as to obtain No. 6; and I should also mount a dry specimen on glass, to keep as a permanent proof. If all the characteristic results followed, I think no one could hesitate in giving evidence that the mark was blood; though, of course, these facts alone would not decide whether or not it was human—if possible, that must

be accomplished by other means, or a conclusion formed from other considerations.

If the quantity dissolved out at first gave a very faint spectrum, it would be well not to attempt to see the spectra Nos. 5, 6, and 7, but to act on the solution with citric acid, filtering, if requisite, and then to add ammonia and protosulphate of iron, so as to obtain No. 8. The material itself might also have so acted on the blood that no other spectrum could be seen. It is, however, so characteristic, that, even then, one could scarcely hesitate in deciding that the stain was due to blood.

If the material had evidently been washed, so that no spectrum could be obtained from a simple solution, having first ascertained what effect citric acid has on the dye, I should digest a stained portion in a solution of $\frac{1}{3}$rd or $\frac{1}{4}$th of a grain of citric acid in a few drops of water, so as not to have more liquid than will fill the cell, filter, if requisite, add excess of ammonia, and then protosulphate of iron. Unless very thoroughly washed out whilst the blood was quite fresh, no mere washing with hot or cold water without brushing or other mechanical means being adopted to dislodge the minute insoluble particles, will so completely remove the stain that it could not be detected in this manner; except, indeed, any of those foreign substances be present which precipitate the colouring-matter in a form insoluble in citric acid and ammonia.

Supposing a clear coloured solution be obtained, which gives a different spectrum or set of spectra to those characteristic of blood, it might be desirable to ascertain the nature of the substance to which they were really due. I have already described the spectra of a few colouring-matters, but in all cases I strongly recommend the study of the spectra of any substances likely to occur in any particular instance. Even if blood has been detected, this would also be desirable, since an opinion could then be given with more confidence.

My conclusion is, that, even in cases where the usual tests would fail, the detection of minute traces of blood need not in general be a weak point in the evidence of crime. Having proved it to be present, the question of its having been human or not must be decided by other considerations; and thus as a positive proof the evidence may be equivocal: but if a stain supposed to be due to blood, which, if it were, would certainly give the characteristie spectra, fail to do so, the negative evidence would be decisive.

7. *Conclusion.*

It is, of course, at first, always difficult to know to what subjects a new form of apparatus may be usefully applied; but I trust that the facts I have described will suffice to prove that, for so simple an addition, the resources of the microscope as an instrument of research are greatly increased by our being able to use it also as a spectroscope.

ON THE HEALTH OF METAL MINERS.

By R. Angus Smith, Ph.D., F.R.S.

Is it, after all, wonderful that a Royal Commission should inquire if the condition of miners is satisfactory? It seems to us that history is full of their sorrows.

When great armies stood before each other in ancient times, it was often to answer this serious question, "Which of us shall live in ease and abundance, and which shall die in the worst of bondage working in the mines?" The miners were always miserable, even if they lived in Attica itself, and but a few miles from the Exchange where the mine-shares were sold.

In our own times the same is repeated, and Poland stands before Russia to answer the question, "Shall we die in the mines?" It was surely by the forced labour of great masses that accumulated waste or *bings*, greater than are known to be raised in modern time, have been collected in Spain, and especially at Huelva. In all known places the work of the mines was once distressing; still a Commission may very well inquire into the mode of cure, as all the evils seem capable of a remedy. There has even been a period in modern history when the work of the mines has risen to be enthusiastically admired, and this spirit is not entirely gone from some districts.

When forced labour ceased, the mines became less deadly, and men who were not observant did not see that they still failed to reach a fair standard of health.

It is a curious thing that a population does not know, and can scarcely be taught, when it is unhealthy. Twenty years ago it was proved that the average age of all who died was, in some places in England, less by half than in others, and yet few people know it even now, but many are constantly boasting of the health of the very towns that were then branded, and have not improved.

The popular proof of the health of a given locality is frequently the attainment of great age by some individual in that locality, as if such a fact could prove either wholesomeness or unwholesomeness. We can only see the influence on masses, and when the thousands of figures necessary for the calculation are reduced to a few. Some close observers and men of fine instincts are to be excepted.

In the General Report on the labouring population, in 1842, by Mr. Edwin Chadwick, C.B., it is said—"On examining the condition of 1,033 men artisans (agricultural labourers), living and working in the vicinity, it was found that their average age was forty years, and that their average period of work then completed was twenty-five years." Of 2,145 miners, the average age was thirty, and they worked fifteen years. Of the mining population, one-third only had attained fifty years of age; of the non-mining, one-third had attained seventy years. This was on the authority of Mr. R. Lanyon, surgeon, in Cornwall.

This book of Mr. Chadwick's began the public sanitary movement which has not yet ceased.

The first view of metal miners is not favourable; they seem a distinct race of men, with complexions entirely new to us. We soon find that this is caused by a peculiar clay which gives their countenances a sallow look. There are, therefore, various appearances as the clay varies. Wash the clay off, and see the men on Sunday, there is still a difference, and "men of certain mines are known by their appearance," as is shown by the evidence of the Mining Commission.* We hope this remark alludes to their Sunday appearance, otherwise it is of less value.

Dr. Peacock says:—"It is impossible not to be struck with the peculiarly delicate appearance of some of them, and especially of the older men and boys, and young men who have worked underground only for a short time. Instead of having the bright and clear complexion of young people employed at the surface, those who labour in the mines have a pale, sallow appearance, and this they seem to acquire even after having worked underground only for a few months. For men following a laborious occupation, they are by no means muscular, and very generally their pulse at the wrist is feeble.

"If inquiry be made of them they frequently acknowledge that they are not in good health, complaining of dyspeptic symptoms, want of appetite, qualmishness, sense of weight or flatulency after taking food, sometimes pain at the pit of the stomach, and occasional vomiting of the food, and an uncertain state of the bowels, either confinement or diarrhœa. Very frequently, also, they suffer from pains in the back and failure of muscular power, or from breathlessness, especially on any active exertion, tightness of the chest, chronic cough and expectoration, and palpitation of the heart." One would think this quite sufficient, but Dr. Peacock gives as the diseases of miners—general debility, indigestion, rheumatism, &c., asthma, bronchitis, or pneumonia, or the two combined, and phthisis or tubercular consumption. To these are added such forms of diseases of the heart as are generally occasioned by any violent exertion, as rupture or injury of the aortic valves.

"Deafness is extremely common, and frequently exists in a marked degree in men who have worked several years underground, and this, too, when they have never sustained any injury from blasts or other accidents."

Dr. Peacock mentions the lowness of the pulse, and it is remarkable that in a series of experiments on breathing in confined air when an air-tight chamber was used, we found that the most striking result was a lowering of the pulse at the wrist. To this was added a rapid breathing. This occurred to such a degree as to lessen the amount of beats per minute by twenty, when it was considered safer to desist.

The habit of smoking, which is much indulged in by the miners, is probably caused by an instinctive desire to quicken the movements of the heart, and certainly this result is produced at the moment at least in some persons, whatever may be the ultimate effect.

If we were reviewing the Report of the Commission and the Ap-

* The report and evidence here referred to are published by the Royal Commission to inquire into the condition of all mines in Great Britain, to which the provisions of Act 2 & 3 Vict., cap. 151, do not apply.

pendix, we should say much concerning Dr. Peacock's Report. He has found, as all men do, when they go among metal miners, that the complaint against bad air is constant. He says—"I have been repeatedly told by miners now at work that all miners have to breathe bad air more or less; or that in all mines there are places where the air is bad." In one place he met several men obliged to give up work for the day on account of the air. "They said that the bad air made them dizzy, sometimes adding, 'as if they had been in liquor,' caused violent headache, and made them feel sleepy, so that they could scarcely keep awake, and took all the power out of their limbs. Sometimes they said they became quite faint; and I was told the men had occasionally fits when working in bad air, and had to be carried out."

Mr. Bankart, of Guy's Hospital, finds also complaints concerning the bad air and defective ventilation; both mean the same thing.

In 150 cases of disease among the miners, he found 102 in the respiratory organs, and 16 in the heart.

Dr. Peacock's results are in the 'West Cornwall Report' (p. 9); Mr. Bankart's are from Cornwall (p. 96).

This medical evidence from experienced men who studied the matter on the spot cannot be overvalued. Let us now look at another kind of evidence, that of figures; and here Dr. Farr comes with his inexorable tables. One cannot wonder enough at these results; they tell the health of a district, as we tell the hour of the day by looking at the figure to which the hand points. Perhaps every illness leaves its mark on the death-rate, and perhaps every joy and every anxiety of mind lie there explained, if we could but read them.

Cornwall is a healthy district, washed by the pure winds and rains of the Atlantic; if the race had any vigour, it must there be nourished, and so we find it.

Dr. Farr finds that the mortality in Cornwall of the male children under five years of age is 55 per 1,000; whilst in Norfolk, an agricultural district, it is 65. Cornwall is, therefore, very excellent for the health of children or it produces very healthy children; in any case, speaking highly of it in a sanitary point of view. The mortality of all under fifteen years of age, of miners and others, is less than the mortality at the same age in Norfolk. Besides this, "the children and the women of these districts enjoy as good health as the children and the women of Norfolk, or any of the other counties."

People like to hear their impressions confirmed by statistics. It has been said that no one can go into Cornwall without observing the very healthy countenances on one side, perhaps because contrasted with those of the miners on the other.

Dr. Farr says that the mortality in Cornwall begins to be excessive at the age of thirty-five. A frequent cause of death is consumption, but as it does not appear hereditary, it is supposed not to be the ordinary disease of that name. (P. 157, the Appendix B., same Report).

The following tables are abridged from those of Dr. Farr. (The headings for the columns in Table A apply also to the corresponding columns in B).

A.—*After-lifetime of Males, or Years of Life after the Age of* 20.

AGE.	Males of all Classes.		Miners.			
	Healthy Country Districts.	England and Wales.	Cornish Districts.	Staffordshire Districts.	Durham and Northumberland Districts.	Merthyr Tydfil District.
	Years.	Years.	Years.	Years.	Years.	Years.
20	43·456	39·425	34·862	33·307	42·016	30·575
30	36·483	32·681	27·755	27·706	34·563	24·841
40	29·342	26·018	20·314	21·644	27·387	19·765
50	22·078	19·545	14·064	15·666	20·447	14·463
60	15·094	13·614	9·688	10·530	13·772	9·079
70	9·356	8·524	6·131	6·502	7·927	5·535
80	5·378	4·992	3·501	4·117	4·196	3·934

B.—*Healthy After-lifetime, or Years of Health after the Age of* 20.

TOTAL . . .	40·5	36·4	31·9	30.3	39·0	27·6
20 to 40 Athletic age	18·0	17·6	17·7	16·5	18·2	16·1
40 to 60 Intellectual age	14·6	13·0	11·5	10·7	14·2	9·4
60 to 70 Mature age	7·4	5 6	2·7	3·0	6·4	2·1
80 & upwards, Monumental age	·5	·2	·0	·1	·2	·0

The deaths by violence in metal mines are not so numerous as one might expect. In copper, tin, lead, and iron mines, the amount is 109 out of 100,000.

Of 382 cases (p. 157, Dr. Farr's evidence), there were—

Crushed or injured by fall of stone .	149
Fell into the pit	122
By blasting	39
By drowning	13
Other methods of violence . . .	59
	382 = 109 in 100,000

In coal mines the number is much greater.

Crushed by fall of coal	236
Explosions	145
Falls in the pit or shaft . . .	92
Blasting	5
Drowning	4
Other causes	16
	498 in 100,000

The same evidence adds that deaths by explosions are only 145, and yet they horrify us the most. We forget the 236 who are being crushed by falls of stone, caused mostly by ignorance or carelessness.

We see that the greatest loss of life begins at the age called by Dr. Farr the "intellectual." There we find that something like a fourth of the time when the intellect is most powerful, is cut off from those men, and two-thirds of the maturer age.

There is not found in the habits of the people, at least in Cornwall, anything to account for these unhappy conditions. Their food may not be the most wholesome that can be obtained, but it is better than the food of some who do not so suffer. This we believe, but cannot enter upon the subject. It is, however, enough to say that the great health of the women and children shows that the evil is not to be found in the food being imperfect.

We must leave others to find out the unhappy and unwholesome dwellings if these exist in greater numbers than elsewhere.

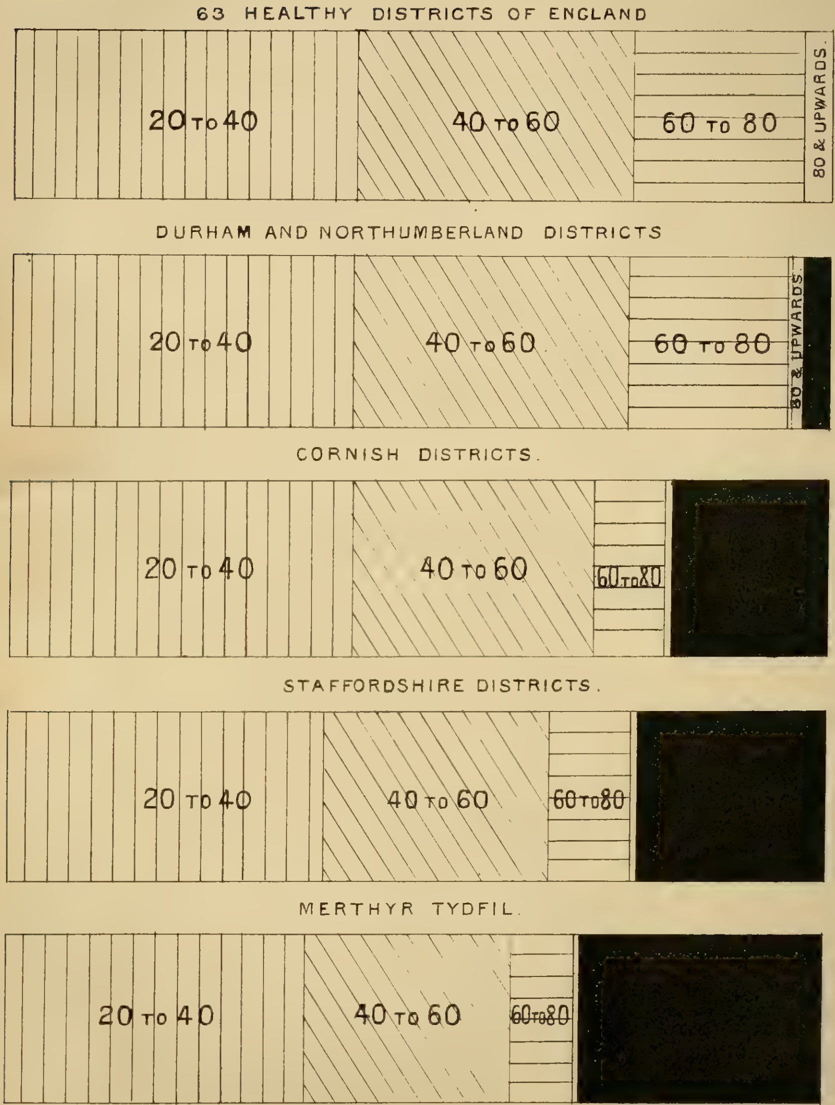
With the behaviour and character of the people we were much pleased, not having ever met a population in apparently better condition.

The great distance of the dwelling-house from the mine is a point of very great importance to the workmen, and yet this inconvenience is almost unavoidable when new mines open. The proprietors may find that they would gain by conveying the men by railway or omnibus. We now know better than formerly that nothing is to be gained by overdriving or overworking; although this is not complained of at the mines. Overwork is done to a great extent willingly, and it will always be done where there is a high-spirited people. The long walks are a species of overwork, which, however, we can scarcely lay to the charge of the employer.

Out of 10,000 who attain the age of fifteen, there were registered as dying:—

	England generally.	Miners.			
		Cornwall.	Stafford.	Durham.	S. Wales.
Diarrhœa and Cholera . . .	547	230	1,052	1,255	1,915
Fever	426	324	385	307	782
Diseased Heart and Dropsy . .	928	484	612	928	333
Consumption	1,523	4,439	680	948	1,604
Other Lung Disease	1,343	1,157	1,975	1,010	1,433
Accident or Violence	532	782	2,782	1,312	2,158
All Lung Disease	2,866	5,596	2,655	1,958	3,037
Lung Disease and Accident . .	3,498	6,378	5,437	3,270	5,195

It is to be observed that Dr. Barham and Mr. Hunt consider that the effect of the mines is seen at an earlier age than shown by Dr. Farr's statistics. The health seems to suffer some time before the death-rate takes notice. Dr. Peacock also considers that the mines



D^R FARR'S DIAGRAMS OF THE PROPORTIONAL NUMBERS OF MINERS, LIVING AT 4 PERIODS OF LIFE, IN 4 MINING DISTRICTS, COMPARED WITH 63 HEALTHY DISTRICTS.

affect the young, and we might collect evidence to this effect from other countries. On this we cannot enter.

The expense of such a low state of health may be more striking to some persons than the enumeration of the years of life.

By the following table we find the difficulty of insurance, which is the more to be lamented, as the miners must be a provident people. Dr. George Smith says that there are 800 houses in Camborne the property of labouring men, nearly all miners. The following is part of another table by Dr. Farr :—

AGE.	Single Premium which will Insure 100*l.*, or Life Insurance at 8 per cent.			Annual Premium which will Insure 100*l.*, or Life Insurance at 3 per cent.		
	Healthy Districts, Males.	All England, Males.	Cornish Miners.	Healthy Districts, Males.	All England, Males.	Cornish Miners.
	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
20	32 3 5	35 14 11	39 4 10	1 7 7	1 12 5	1 17 0
30	37 11 7	41 14 1	36 14 5	1 15 1	2 1 8	2 11 0

It is probable that the diagrams of Dr. Farr (*see* plate) will illustrate the subject more clearly than any of the tables. We see the lifetime of healthy males in England in the first diagram; in the second there is a dark space with no lines; in Cornwall that space greatly increases, and in Merthyr Tydfil takes up a third of the ground. Take also middle and old age—the space gradually diminishes. We hope that some one will write on the social condition of those people. We believe that in Cornwall there is found a class who have made such advances as are very rare.

The sum of the argument is, that Cornwall is an extremely healthy county; that the general population is very long-lived; that the miners are a very short-lived race; that the social habits of the miners are not such as can account for the great diminution of the length of life, which is due consequently to the condition and work of the miners.

The Air of the Mines.—If the evidence against the ladders is great,* that against the air is great also. In all inquiries there are men who have particular favourites among the various views of a subject. They desire that one side shall be the winner, and for no reason that they can give. We think the cause is this :—they admire that which they first learnt or understood, and especially if they thought of it themselves. It is the same as bigotry or superstition. We have a curious instance of it in seeking the causes of disease in Cornwall. Some persons would not understand what miners' consumption meant,—would not acknowledge having heard of it. Others, and these are many, do not believe in the existence of unwholesome air, and trace everything to the ladders, forgetting that the miners' disease is cen-

* *See* p. 63, No. 5 of this Journal.

turies old, and existed before great depths were attained—forgetting too, that the air is not bad in proportion to the depth—forgetting too, that unerring instinct of the miner which for ages has led him to fear the foul air and the "demon of the mine," which sometimes strikes him suddenly dead with his foul breath.* The greatest evils from the air are felt when the men are down the mine, not after they have risen to the surface and are suffering from fatigue; but the great depth may and does cause some of the most dangerous symptoms after the exhaustion of mounting. Let us be satisfied that every evil demands a cure, and if one evil be somewhat smaller than another, let us nevertheless seek to eradicate it. We believe the greatest evil to be foul air; perhaps also, from some bigoted feeling, and perhaps because we know most about it; but we cannot cease to admire him who diminishes the labour of mounting the ladder steps.

The author of this paper examined the air of the mines and has given, in his report, an analysis of several hundred specimens. This report begins first by inquiring into the composition of the air. Hitherto it has been given with differences of one-tenth per cent., or one thousandth part, forgetting how much one in a thousand of air is, and that we can trace in a moment the presence of some substances even to a millionth, perhaps far beyond this. The air at various times and in various places was found to differ in the amount of oxygen. The author does not suppose that the loss of the minute amounts of oxygen in some of these cases is of consequence, except as an indication of the presence of other gases. It may even be that in the higher numbers with small differences some uncertainty exists, but as a whole, the gradation in the following table came out after arranging five or six hundred analyses, and was entirely unexpected.

Analyses of air varying in the amount of oxygen (per cent.):—

N.E. Seashore and open heath of Scotland	20·999
Tops of hills—Scotland	20·98
Base of hills—Scotland	
Suburb of Manchester in wet weather	20·98
Front Street—¾ mile from Exchange—dry	20·945
Back of house	20·936
Unhealthy parts of Perth—favourable or windy day	20·935
Fog and frost in Manchester	20·91
Sitting-room which felt close	20·89
After six hours of a petroleum lamp	20·83
Pit of Theatre	20·74
Gallery	20·36
When candles go out	18·5
Difficult to remain in	17·2

This table is given in order to enable us to compare the air of mines with purest air and with ordinary bad ventilation. The closest gallery of a theatre did not lose above one-third the amount of oxygen lost in the average of all the mine air. How low the amount must in many cases have been to produce this low average may be imagined,

* If this seems only a metaphor it was none to the old miners, who have left descriptions of several species of demons.

and, as far as figures show, it may also be seen in the report alluded to, and in part in the above table.

Summary of the Analyses of Air in Mines.—Oxygen.

Average in 339 specimens	20·26
Lowest	18·27
Average in large spaces	20·77
Currents	20·65
Just under shafts	20·424
In ends	20·18
In sumps	20·14
In all other places	20·32

Air with 20·9 of oxygen was assumed as normal, or nearly so, although the figure is too low. Air with less than 20·6 was assumed as exceedingly bad, because it is not equalled in our most suffocating assemblies.

Let us compare the mine-air with the atmosphere of various places in relation to carbonic acid.

Analyses of atmospheres varying in carbonic acid.

	Average Carbonic Acid per cent.
Manchester streets—usual	0·0403
During fogs	0·0679
About middens	0·0774
Average	0·0442
Fogs excepted	0·0424
Fogs and middens excepted	0·0403
Where the fields begin	0·0369
In close buildings	0·1604
Minimum of suburbs	0·0291
Over North Scotland (towns excepted)	0·0336
Candle goes out	1·8 to 2·5000
Lowest found in mines	2·5000
Lowest entered for experiment	4·0000
Average of the mines	0·7850

These figures may be read as whole numbers; for example, average of the mines, 7,850 in a million.

And why should we be afraid of a little carbonic acid? Because carbonic acid deranges the circulation, causing at first sometimes a rapid beating of the heart, but ultimately a very low and weak pulse, and a quickened respiration, although at times a somewhat slower respiration. It is never indifferent, and the effect may be traced when even so little carbonic acid exists as one-tenth per cent. This is a sufficient reason for ventilating and for seeking pure air.

Chemists have often asserted that foul and pure air have the same composition; this need no more be repeated.

Calculated Composition of the Air of Mines in some Places.—If we put together all the substances thrown into the air when two miners are working in a space equal to 1,200 cubic feet, we have as air and impurities together—

	Grammes.	Grains.
Oxygen	9048·957	139737·7945
Nitrogen	33726·7	520470·4
Carbonic acid	1200·44	18525·2
Carbonic oxide	3·188	49·2
Hydrogen	0·07186	1·1088
Sulph. hydrogen	0·59869	9·23898
Sulphate of potash	144·760	2233·936
Carbonate of potash	43·311	668·375
Hyposulphite of potassium	11·189	172·668
Sulphide of potassium	7·296	112·592
Sulphocyanide of do.	1·049	16·186
Nitrate of do.	12·751	196·773
Carbon	2·494	38·482
Sulphur	0·466	7·191
3/2 carbonate of ammonia	9·790	151·079
Organic matter		
Sand		
Sulphurous acid, or		
Sulphite of ammonia		
Arsenious acid		

Organic and Solid Matter.—The reason we feel ill in air having only from one to two-tenths of carbonic acid, is mainly owing to the organic matter by which it is accompanied. The mines contain such organic matter also, and if not in the same proportion as in crowded rooms, there are other substances, as we have seen, which make up for it. If we are suddenly brought into a crowded room, it is very unpleasant; but if the room is emptied, and the air has time to change, it is not less unpleasant to breathe for some time, because of the organic matter which has been left clinging to everything. Mine air, however, is still worse; if you take a cubic inch of it away to a spot where the air is pure, and then breathe it, you will have obtained a good specimen, if you do not smell grease, tobacco, and sourish perspiration, or you may perhaps consider it a little putrid. We never go at once into a mine; we can only go gradually. How dreadful to be launched at once into an atmosphere, a cubic inch of which is more than enough to give rise to unpleasant sensations to half-a-dozen persons! Yet such air exists in the mines.

Smoke and Dust.—But these things are not all. There is in the air a great abundance of solid substances. These are found on the sides of the tubes of collected air, and were examined by the microscope. They consist of sand and of carbon, but also of crystals of sulphate and nitrate of potash. The sulphide of potassium goes into sulphate, and some of the gunpowder is not decomposed. The men breathe these continually.

Sometimes at dead ends or extremities of levels, especially when there is a rise, the air is such that no man can work above ten minutes, and they take it in turns. So we have been told by miners; we have not been in such places in mines, but we do not feel surprised at the assertion.

Water and Boilers.—We can only say a few words on boilers.

In the evidence adduced by the Commissioners we are surprised to hear that the boiler is considered so unusually dangerous ; it is true we have found sulphate of copper in water used for raising steam, but surely this cannot be commonly used in Cornwall. Water such as that is most destructive, as it dissolves the iron rapidly.

Whilst speaking of this subject, we may mention the very beautiful discovery of young Dr. Bischoff, of Bonn. He finds that the oxide of iron, of which there is so much where pyrites is burned, can in a very moderate heat be converted by carbon into metallic iron, still retaining its fine texture. Water passed through this is freed from copper in an instant. This may in some places be found a valuable process. It is not absurd to expect that the process may be available, so far as to bring drinking water within the nearer reach of some of the miners, because, if the copper is removed, it is easier to remove the iron.

We shall be asked, What interest can there be in providing water for a county like Cornwall, in which the winds from every quarter are said to bring rain ? But, true as this may be, we have found persons going two miles for water to drink. The streams are poisoned, and the carriage of water is one of the greatest burdens on the poor of some districts.

How do Miners know that the Air is Bad ?—They actually wait to see if a candle will burn in it. Let us imagine people in a ball-room saying, " This room is well fitted for dancing, and is well ventilated, because the lights are burning, and we can see the people." No ; we have learned that people may faint even when the lights burn well ; and we never yet have heard of people dancing until the lights went out for want of air. No such foolish persons have, in all probability, ever existed. Still the work of the miner is nearly as hard as dancing, and he sometimes remains until the impurity has increased till it is thirty times greater than the amount of increase that is considered admissible in well-regulated houses.

Wet Clothes.—The miner is one of the few, if not the only man, who works in a warm and moist climate during the day, and comes at night to real winter in his wet clothes. The Commissioners recommend changing-houses at all mines; and Lord Kinnaird has given a model of one with every convenience.

It must not be supposed that every miner is wet, or that every mine is unprovided with a warm changing-house. We have met miners who preferred to work below because it was dry, and free from the cold winds and storms of the upper world, or " the grass," as they called it.

In some districts there is an actual dispute among men as to the advantages of the two worlds—the one below or the one above. Still the medical witnesses consider the moisture one of the greatest evils, and the cause of frequent rheumatism.

Heat—is not in proportion to the depth of a mine according to the agreement of all, but it is said to be greatest where there are sulphur compounds. The oxygen is in all probability admitted by the mining openings, and a slow combustion begun, if it did not exist previously, although to a small extent.

Mr. Edwin Chadwick said, twenty-one years ago, speaking of Dolcoath, one of the oldest and greatest mines—"Care is taken of the miners on quitting the mines; hence, instead of issuing on the bleak hillside, and receiving beer in a shed to prevent chill and exhaustion, they issue from their underground labour into a warm room, where well-dried clothes are ready for them, and warm water and even baths are supplied from the steam furnace; and, in the instance of this mine, a provision of hot beef-soup instead of beer is ready for them in another room.* The honour of having made this change is said to be due to the Right Honourable Lady Bassett, on the suggestion of Dr. Carlyon. "The ventilation is particularly good, and the men healthier than in most other mines."

Cornwall does not seem to be far advanced in the knowledge of sick clubs. Mr. Tidd Pratt has given a code of laws for them, appended to the Commissioners' Report. The Report recommends a system that would give help in sickness, as well as in cases of accident. With a population evidently disposed to carefulness, much is to be done by a good organization.

The Commissioners recommend that boys under fourteen years of age should not go down the mine.

Abandoned shafts have the care of the Commissioners; and certainly there are districts where the surface is covered with such pitfalls, which stand ready to hide unnumbered crimes.

Returning to the question of ventilation, the Commissioners are fully aware that there may be a diversity of plans used; they say—"In small mines, and in certain parts of large mines, a good supply of air may be provided by means of contrivances which cannot be economically supplied on a large scale, such as different descriptions of air-pumps, water-blasts, and fans."

The Commissioners recommend "the rarefaction of the air in one of the shafts by the heat of a furnace." "A system of Trunk ventilation being thus established, the pure air may be guided to any part of the mine," as in coal pits.

The ventilation is sometimes naturally very good, that is, the foul air goes up one shaft and fresh air down another; but this is not so in all mines, nor in every state of the weather. This cannot happen when there is only one shaft, or an insufficient communication by winzes, and a neglect in the guidance of the air. To these points the recommendations are directed.

The amount of air driven through coal pits is enormous; but in metal mines such an amount is not required, and smaller fires would be sufficient for the purpose. In coal pits the carbonic acid and carburetted hydrogen issuing from the coal, render great currents of air necessary, not merely for breathing, but for preventing explosions.

Among miners some, of course, are highly advanced, but according to the evidence given before the Commissioners, there are to be found men who work in dangerous places knowing the dangers; agents who refuse to supply air to the men, or delay it too long; men so

* The soup is not continued we believe.

Warren De La Rue, del.

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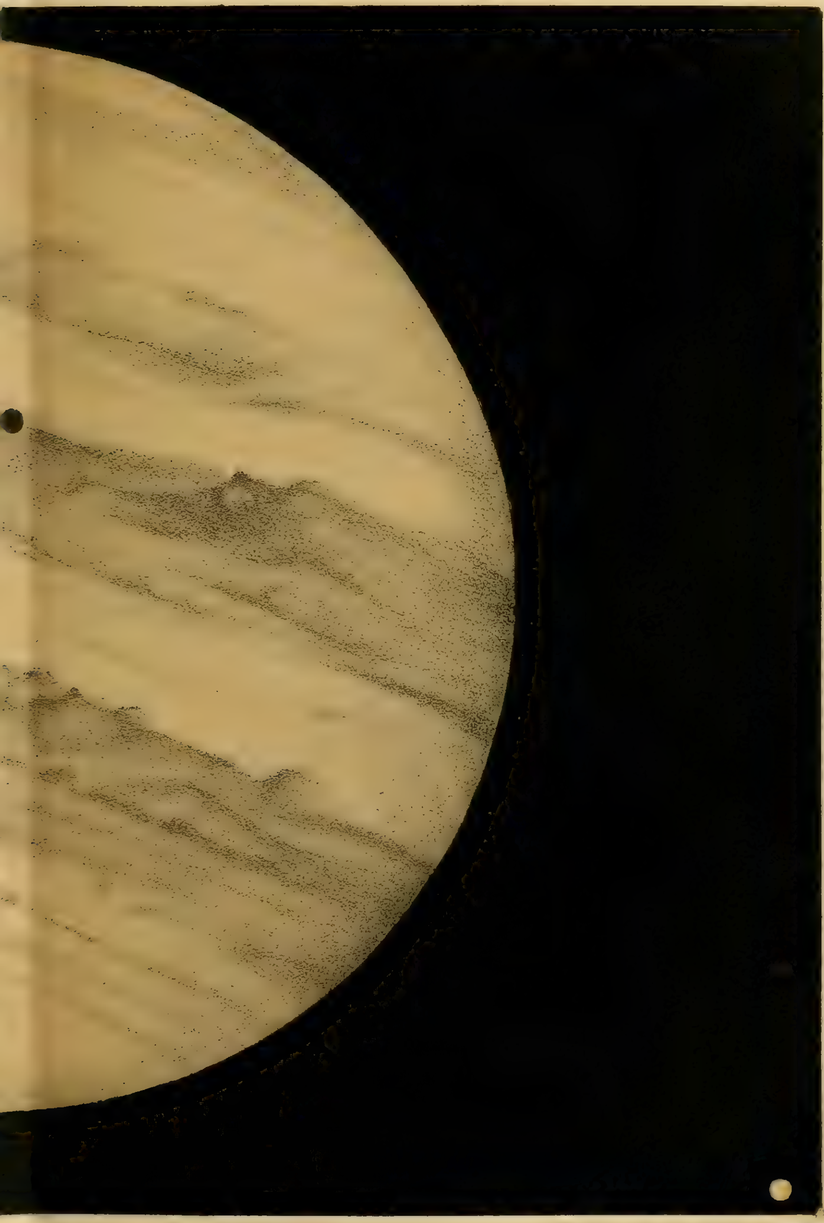

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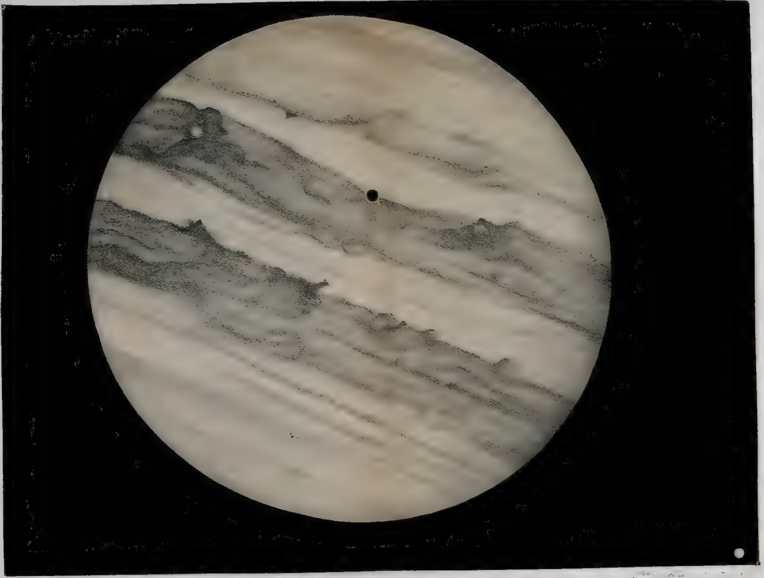

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ignorant that they imagine they may work safely if the candle burns even dimly. We have heard it said that they actually advance into places where the candle will not burn, leaving it behind. There are also men who pay 72*s*. for work which could be done in pure air at 45*s*., but who still do not ventilate sufficiently; men who risk their lives, perhaps unwillingly, but because of their poverty. There are men who doubt whether any of the evils of mines come from bad air, although the whole history of the art presents to others one volume of proof that it is really so. By whatever method pure air is obtained, it is essential that it should be supplied: every miner agrees that the cure is possible. If we examine any other subject of complaint, the same conclusion is attained: a cure seems to exist for all. We find mentioned a remedy for the wet clothes, so often worn by the men on their way home—for the evils of unsheltered places where women and children take their meals—for the excessively long ladders—for the unbratticed shafts—for the unguarded sumps, winzes, and shoots—for the careless blasting—for the lax method of reporting the condition of the mine—for the bursting of boilers—for the inconvenient changing-houses—for abandoned shafts—for the too early entrance of boys underground, and for the want of sick clubs.* It may be added that pure air seems to promise a commercial advantage where a loss is much too common.

It would appear as if more than enough has been shown to prove that no time ought to be lost in devising a mode of encouraging those means of safety already known. If attention to the subject is fostered by Government, invention will introduce numberless facilities, whilst difficulties which are even now few will cease. In time, workmen and masters will be equally thankful for such attention, as it promises to increase the wealth of both, and render longer and happier the life of the whole mining community.

ON A PLURALITY OF WORLDS.

By WM. CARTER, M.B., B.Sc., Lond.

THE belief in the plurality of worlds, which has existed for the last three centuries, has been engendered by different circumstances, and held on very different grounds and with varying force accordingly. The revelations of Astronomy, by establishing certain general resemblances between the terrestrial globe and some of the heavenly bodies, and by proving the operation on all of these alike of physical influences, differing only in degree, were alone sufficient to cause many to receive it almost as a settled truth. Others have had their belief strengthened by the progress of Biology, which has shown that there is no spot so insignificant, and but few conditions so strange, as to be incompatible with life; that on bare granites, as well as rich alluvium,

* See the recommendations of the Commissioners.

in the fervid tropics, as well as in regions of almost perennial frost, in ocean depths so great as to be impervious to the faintest ray of light, and where the pressure of superincumbent water equals a ton-and-a-half on the square inch, as well as in the highest and most attenuated regions of the atmosphere attained to, living beings abound. While yet others, by adding to their knowledge of the present universality of life that of its equal extension during the measureless ages of the past, have had the conviction forced on them that it is always and everywhere co-existent with the conditions fitted for its maintenance. For Geology, leaving the fair face of the green Earth and proceeding step by step down towards her awful foundations, points out the evidences of many a world long since passed away, with physical conditions differing often from those which prevail now; while, at the same time, she lays open the silent tombs of innumerable and strange creatures, to whose organizations such conditions were most minutely adapted. And yet, after having descended into the regions of an immeasurable antiquity, she is obliged to confess her inability to reach the beginnings of life on the Earth, admitting that, for aught she can tell, as extensive an animal and vegetable series might have existed previous to, as since, those earliest traces which she has yet discovered. For every new revelation serves but to strengthen the probability that the entire series of rocks is passing through a ceaseless cycle of change, and that granite itself may be but the extreme term of a metamorphism, that by its intensity has obliterated all vestige of organisms with which it might once have abounded. Certain it is that the Histiodermas and Oldhamias of the Cambrian period have lately been proved to be recent compared with the incalculably more remote Polyzoa and Foraminifera brought to light in the lower rocks of the Laurentian series, which, in their turn, will probably be shown to be as far removed from organisms of an earlier period yet to be discovered.

Although, however, life is so widely diffused, it must be admitted that so far as we are cognizant of it, it cannot exist in the absence of certain conditions. Whether other forms, of which we know nothing, may do so, is an irrelevant inquiry.

The question to determine then is, whether such conditions exist on other planets: and to what is known of the physical constitution of these, we shall accordingly direct attention, passing by, as of too uncertain a nature for our present purpose, all speculations on Cosmogony, or on the probability of the sun's being a variable or a nebulous star or member of a binary system, &c. To begin with elementary constitution—this may fairly be concluded to be similar in all the members of the solar system, for since iron and many other elements are proved by spectrum-analysis to be present in the Sun, and by direct chemical processes to form part of those small bodies which as meteors occasionally strike against the Earth; and since there can be no possible reason why such elements should be found in these distinct members of the series, and yet be excluded from the rest, the only fair conclusion is, that they enter into the composition of Venus, Jupiter, and the other planets also. Moreover, the study of meteorites

has shown that olivines, augites, anorthites, and other minerals analogous to, though not strictly paralleled by, those of the earth, abound beyond its limits; while by a microscopic examination of the sections of these Mr. Sorby has further shown that they have excellent glass and gas cavities, like those present in lavas, proving that they once contained vapour, and were in a state of igneous fusion. A very intimate resemblance has thus been proved to exist between different bodies in the solar system; while by methods of research, available for the examination of the physical constitution of bodies beyond its limits, this resemblance has been found to extend in some respects to them also. For the spectroscope reveals the very suggestive fact that many of the fixed stars have at least a considerable proportion of similar chemical elements to those which abound in the Sun and Earth, and that the ones which are most extensively diffused, and of whose evidence the clearest indications are afforded, are such as are known to be most closely connected with the constitution of living organisms, —just those indeed, which, when influenced by heat, light, and chemical force (all of which are undoubtedly radiated from these stars), afford some of the most important conditions for the maintenance of life.* True it is that no undoubted organic remains have yet been discovered in any meteorite, or other body outside of the earth. Hydrocarbons were, however, present in the stones of Kaba Bokkereld, &c., and it is perhaps fairly open to question how far these may not indicate the operation of organic agency.† But a similarity in elementary constitution among the different members of our system, necessarily implies other conditions, which serves to bring still closer the likeness to one another. For so soon as a number of chemical elements are in a position to exercise their natural affinities, local forces of great intensity are developed, which inevitably give rise to irregularities of outline. The same is true of the simpler minerals which these elements by their union form, many of them assuming such different volumes under similar circumstances of temperature and pressure, as to be competent to the production of extensive fractures, elevations, and contortions in any mass of which they form a considerable proportion. Thus, while granites, syenites, and basalts diminish in density, though in very different degrees upon the application of heat, zircons, yellow obsidian, and others, augment. The variety of surface thus physically inevitable from the possession by the planets of a similar elementary constitution, explains and gives additional force to the interpretation of appearances visible through the telescope. If in addition to this superficial inequality, water can be shown to be present, there will be on other planets the elements of that ceaseless cycle of geological change which is so marked on our own, namely, attrition, disintegration, lamination, and stratification, causes which combine for the production of fertile soils. That this is present in abundance will be evident when we inquire more particularly into the physical constitu-

* 'Phil. Trans.' for 1864. "Huggins and Miller on Spectrum-Analysis of Fixed Stars."

† 'Proc. Roy. Inst.' and 'Trans. Brit. Assoc.' "A. S. Herschel, B.A., on Meteorites."

tion of each. Previously to this, however, it should be said, that much more is known of some than of others, proximity to the sun in the one case and distance from him in the other, rendering observations on the extreme members difficult and uncertain. But, without inquiring into the exact limits of fair analogy, it will be readily granted that where, in case of a strong presumption existing in favour of an adaptation productive of some degree of similarity throughout the members of a related series, such an adaptation can be clearly proved in respect of two or more, the presumption is immensely strengthened that it extends to all. With respect to Mars, however, the proofs for this are complete; and in the case of Jupiter and other planets, as much so as the difficulty of observation can render them.

Moreover, where actual experience cannot be obtained, the want of it is no argument against a given probability. It is quite conceivable, for instance, that the animals obtained by Torell, Milne-Edwards, Dr. Wallich, and Lieutenant Brooke, from the black depths of an almost fathomless sea, under a pressure which not long since was thought to be utterly incompatible with life, might, if endowed with reason, and arguing from their limited experience only, question the possibility of creatures organized like themselves existing in such widely different conditions as those of their own station on the one hand, and such as are supplied by shallow water and abundant sun-light on the other. And yet, we now know that such reasoning would be inconclusive, because in these opposite circumstances creatures with precisely similar organizations do live.

To come now to what is known concerning the physical constitution of different members of our system.—The Moon, from being nearest to us, is of course best known; the charts of Boer and Mädler, and more especially the beautiful photographs by Mr. De La Rue, and models and drawings by Mr. Nasmyth, having made the part that is turned towards the Earth familiar to most people. So far as our present means of judging extend, this part cannot be inhabited, because many circumstances prove it to be devoid of an atmosphere. The chief of these are the want of appreciable refraction, the sudden extinction of small stars by her limb, and the absence of any atmospheric lines whatever in the spectroscope; although by this latter method very small portions of her surface can be separately examined. Thus, Mr. Huggins and Dr. Miller were able to observe parts equal only to ·0000346 of the hemisphere, or about one-third the size of Tycho, a lunar mountain some 19,000 feet high. But this uninhabitability of the Moon, even if it could be shown to extend to her entire surface, so far from weakening the opinion that the primary planets are tenanted serves only to strengthen it, because just those respects in which they differ from her are the ones which are known to be essential to the maintenance of life, and, therefore, the existence of such differences renders more probable the existence of the ends to which they are known specially to minister. But from the uninhabitability of the proximate surface of the Moon, we are not warranted in concluding anything concerning the remote hemisphere, the physical conditions of which, with the exception of those of the small portions seen during her librations, are utterly unknown; and that it may possess the con-

ditions of habitability is by no means impossible, for Prof. Hansen, as a result of his inquiries into the causes of the secular variation of the Moon's mean motion, has arrived at the conclusion that her centre of gravity and the centre of her figure do not coincide, the former being so much farther from the Earth, as to give to the proximate hemisphere a bulging of twenty-nine miles over the remote one; so that it would not be impossible for a considerable quantity of water to be collected on this without there being evidence of it to us, something like a parallel to such a condition being found, says Sir John Herschel, in the immense preponderance of water in our own southern hemisphere.

On turning to the primary planets, we are met by positive evidence of a very remarkable character. Combined observations on the best known of these, namely Mars, and especially the recent ones of Mr. Phillips,* show clearly that the climatal variations "are comprised within nearly the same thermal limits as those of the Earth," rendering certain the operation of some adapting cause; inasmuch as the relative distances of the two from the sun being as 100 to 152, and the solar influence therefore as 231 to 100, without it, the planet's surface, instead of possessing the genial temperature which it does of 40° to 60°, should be fixed in perpetual frost. This conclusion as to climate is deduced from tracing the changes which take place with variation of season in certain white glittering masses in the neighbourhood of the poles. The existence of these was first pointed out by Maraldi, in 1716, and the phenomenon explained by Sir William Herschel as due to the alternate accumulation and melting of large quantities of snow during winter and summer respectively. All subsequent observations have served but to confirm this opinion. Thus, Lord Rosse watched the planet for several months in succession, and observed the following changes. On the 22nd of July, 1862, when his first observation was made, the South pole, which, owing to the high inclination of the axis, could at the time receive but little solar heat, was in winter, and surrounded by a large white patch, having a radius of at least 500 miles. In the course of three months, however, during which it had been brought more under the sun's influence, this was reduced to less than a half, and appeared only as a small glittering ellipse. What renders the analogy with the Earth even more striking is, that in the same seasons of different Martial years, the amount of snow appears nearly equal; that it in no case is regular in its limits, but is collected along one or two principal tracts as far as 40° or 45° from the pole; and that it is invariably very excentric round the Southern pole, the amount of excentricity amounting, according to Secchi, to 17° 42′. The only probable explanation of these latter phenomena being the production of local elevations and depressions of temperature by the relative distribution of land and water, the constant set of warm aërial or oceanic currents, and so on, which we know cause the most marked inequality in any of the isothermal lines in our own Northern hemisphere. Local patches, similar to those about the poles, have at different times been seen in other parts, though of far less extent. The geographical limit of the isothermal, 32°, has been shown by Mr. Phillips to be

* 'Phil. Proc.' vol. xii. p. 431 *et seq.*; and No. 71.

very little different from what it is on our Northern hemisphere, extending according to local peculiarities, such as those presented by the elevated table-land of Northern Asia in this case so low as from 40° to 60°, while on Mars the farthest limit yet known to be reached is 50°; the mean summer temperature of which, supposing the pressure to be the same as on the Earth, cannot therefore be less than 32° Fahr., and in many parts must be very much above it. Fifty is nearly the latitude of London; the mean annual temperature of which is 46°·9 Fahr.; but supposing the Earth were moving in the orbit of Mars, with only her present atmosphere, this temperature would be reduced in consequence of diminished solar influence to 2°·03 Fahr. Obviously, then, there must be some great modifying causes at work to counteract the effect of the planet's increased distance from the sun. What these most probably are, we shall consider when we come to an examination of Jupiter. For the present, we will only remind the reader of Professor Tyndall's experiments, showing that the effect of the distribution of aqueous vapours through an atmosphere is to prevent the dissipation of thermic rays into space, and to envelop the surface around which it lies in a warm mantle. Besides the evidence afforded of a Martial atmosphere by the phenomena described, independent proofs have been obtained by spectroscopic examination, so many strong lines being seen in the extreme end of the red, and such well-marked bands at the opposite part of the spectrum, as to render it certain that the atmosphere is of considerable depth.

The other superficial features of the planet are so striking, that drawings made by Mr. De la Rue, and the late Captain Jacob, of Madras, were referred to a Committee of the Royal Astronomical Society, with the view of mapping it out. Two of these, by the former gentleman, form a part of our illustration, and are peculiarly interesting, inasmuch as they exhibit Mars under the two different aspects, consequent on the axial rotation during an interval of two hours. In India, where atmospheric conditions are very favourable for observation, his aspect is exceedingly beautiful, and begets the inevitable conviction of his being, as described by Mr. Grant, "a perfect little world, with continents and seas like ours." In the drawings of Captain Jacob, representations are given of what appeared to him a chain of lakes near the South pole, similar to, though larger than, those of North America; and to all observers there is a marked difference of hue on different parts of the surface—some (the land) appearing red, while others (the seas) look greenish. There is also indication in the occurrence of temporary fogginess of detail of considerable atmospheric vicissitudes.

On considering the physical constitution of Mars, can we conceive of anything in it incompatible with life? On the contrary, does not the presence of the precise conditions, which we know to be adapted to its maintenance, afford us the best evidence for believing in its manifestation?

The position of Venus with respect to the sun is such, that even in the improbable absence of a system of compensation of the opposite tendency to the one which operates on Mars, there would be nothing in it to render her uninhabitable, the mean quantity of light and heat

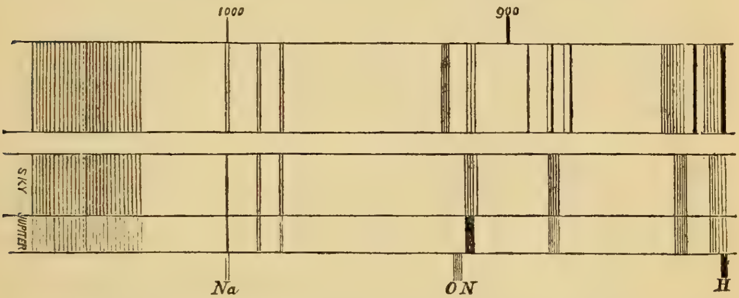
Warren De La Rue, del. Hanhart, Imp^t Edwin M. Williams, lith.

MARS.

N° 1. APRIL 20th 1856, 9hrs 40min G.M.T. _ N° 2. APRIL 20th 1856. 11hrs 45min G.M.T.

various atmospheric and other gases; Prof. Tyndall having shown that while oxygen, nitrogen, and some others, are, like rock-salt, absolutely diathermic, and dry air nearly so, carbonic acid, marsh, and olefiant gases, when compared with the latter as 1, possess absorptive powers of 90, 403, and 970 respectively. Obviously, therefore, the diffusion through the atmosphere of a considerable quantity of either of these gases, which unlike aqueous vapour are incapable of being deposited in a condensed state, would by preventing the dissipation of heat by radiation, keep up a high degree of general warmth. Some such condition of atmosphere may have existed previous to, and during, the Carboniferous period. Another cause, and one on which, from the proof that is obtainable of its operation on other planets, greater stress must be laid, is varying depths of atmosphere. Although the evaluation of the intensity of this has been recently shown to be rather less definite than was supposed, it is still sufficiently so to be made the basis of very important conclusions. The most general fact noticed by all scientific aëronauts, from Gay-Lussac to Glaisher, is that there is a very marked diminution of temperature with ascent into the higher regions of the atmosphere. The theoretical value usually assigned to the decrement is 1° for every 300 ft., and this was the actual value found by Mr. Welsh, in 1822. Mr. Glaisher has come to the conclusion that this result is generally true up to a height of 5,000 ft., when the sky is partially cloudy, the diminution, however, even within these limits, being in a greater ratio in the lower than in the higher strata. Above 5,000 ft. he found the decrement reduced to 1° in every 1,000 ft. Gay-Lussac, who ascended nearly 23,000 ft., found the temperature reduced from 82° on the surface to 15°. Mr. Hopkins, of Cambridge, has applied these data to determine the question of how far different atmospheric depths alone would affect the temperature of different planetary surfaces. According to the ordinary law of radiation the amount of heat and light at Jupiter would be as 1 : 27 compared with that at the Earth. If our planet, therefore, were moving in Jupiter's orbit with her present physical arrangements, the mean annual temperature of her equator would be—34°·42 Fahr. (—36°·9 C.), and at the pole a little more than —39°·1 Fahr. (—39°·5 C.), and 35,000 or 40,000 ft. of our basic atmosphere would elevate the equatorial heat to an equality with that of our present temperate zones. At the other planets a proportionate addition or subtraction would be attended with proportionate effects. To inquire now into the physical arrangements on Jupiter; telescopic observations prove that the light from him is mostly reflected from cloud-like masses above his surface, the intensity of the whiteness of this light exceeding that reflected from any known opaque substance, and being far greater than that thrown off from an equal area of new fallen snow, and fourteen times greater from any given space than that from an equal surface on the full moon. If these masses should be proved to be clouds they would afford unmistakable evidence of an atmosphere, though the depth would still remain unsettled. On both these points, however, there is very satisfactory evidence. For, from the fact that the dark lines in the solar spectrum increase as the sun's altitude

lessens, and his rays consequently traverse greater lengths of atmosphere, an element has been obtained which serves as a standard whereby to judge of the existence of atmospheres around other planets. Many observers have decisively settled this point with regard to Jupiter, Saturn, and other members of the solar system. For, by comparing the spectra of the Moon and Jupiter when at the same altitude, and when therefore the light reflected from them was under precisely similar atmospheric conditions, bands were present in the former which were not found in the latter, and which were due therefore to some modification before reaching our atmosphere.



The drawing which, through the kindness of Mr. Huggins, we are able to give, demonstrates this even more satisfactorily, for, in the observation of which it is the result, the spectrum of Jupiter was seen in direct contact with that of the sky, and the lines in both were seen to be exactly coincident. The comparison in this case was rendered possible by the slit in the spectroscope being greater than the telescopic image of the planet, and by there being just enough light left after the sun had gone down to form a visible spectrum of the sky, which therefore was directly superposed on that of Jupiter. Though co-incident in position the lines will be seen to vary somewhat in intensity, those at 882 and 833 being less intense in Jupiter's spectrum, while those at 914 are stronger. The coincidence probably shows, as Mr. Huggins and Dr. Miller remark, that the planet's atmosphere, with respect to some of its elements at least, is similar to ours. Other lines were present, but were too faint to be represented. Many more, however, have been given by Father Secchi, some of which have no representatives among lines due to our atmosphere, while one of those most closely coincident is always found to prevail during foggy weather.

But the vapours which produce these atmospheric lines in the solar spectrum are principally found in the lower and denser parts of the terrestrial atmosphere, while the parts corresponding to these on Jupiter are not traversed by the light, forming his spectrum, which, as before observed, is reflected from cloud-like masses above the surface. Therefore if there is an atmosphere dense enough to give such well-marked lines *above* these clouds (as we shall show them to be),

that beneath them must be much denser; still, the whole much deeper than ours. The effect of such an arrangement in elevating the general temperature has been already pointed out. The position, form, and movements of the planet's clouds were admirably seen by Prof. C. P. Smyth, under the fine atmospheric conditions afforded by an elevation of 11,000 ft. on the Peak of Teneriffe. "There," he remarks, "the mere streaky bands which cross his disc become resolved in the telescope under high powers into regions of cloud. The brighter spaces were the clouds, and their forms were as characteristically marked and were drifting along as evidently under the influence of a rotation wind as the cumuli and cumulo-strati, which the terrestrial N.E. current was at that moment bringing past Teneriffe under our feet—while in addition there were minute changes in the relative positions and forms of the vaporous masses in either hemisphere, indicating as well the presence of wind as the ephemeral nature of mist. Far more striking, however, was the testimony borne by the more constant form of the clouds seen best towards the equatorial parts of the planets. At this tract one could not gaze long without acquiring the impression of looking at a windy sky; the whole zone of vapour seemed to be in motion, while from its ragged edge portions were torn off and were driving along, some of them rolling over and over, and others pulled out in length."

A better description of a clouded terrestrial sky could scarcely be given. One very suggestive feature was noticed clearly by Prof. Smyth, namely, that the comparative calmness in the equatorial region which has been so often observed, and which as he remarked seemed more inclined to strati and cirro-strati than to the tempestuous cumuli of the tropics, was not exactly coincident with the equator. This is also evident in the beautiful drawing of Jupiter, by Mr. De la Rue, which forms one of the illustrations to this paper, and "seems to require the operation of some such cause as makes the southern trades overbalance the northern ones on the Earth, and throw the zone of equatorial calm into northern latitudes, namely, the unequal distribution of land and sea surface in the two hemispheres." Besides the appearances above described, which are the ordinary ones, there are others at times indicating greater periodical changes, such as large black tracts, numerous glistening spots, &c.

In the conditions of Jupiter thus far ascertained, in many respects so analogous to those which prevail on the Earth, none appear which are inimical to life—none, indeed, wider than are known to embrace it within their limits. The increased weight of bodies on his surface, owing to his greater attraction, when subjected to the reductions due to his larger radius, less specific gravity, and increased centrifugal force (which last is sixty-three times as great as the Earth's), would be less than two-and-a-half times what it is on our planet, a difference scarcely without parallel in cases of living animals possessing nearly equal muscular power.

The very small angle of 1° 18′ 52″ which the planet's orbit makes with the ecliptic, combines with his dense and vaporous atmosphere to produce a considerable equality of climate on all parts of the surface.

The quantity of solar light at the outside of the Jovian atmosphere, though but in the proportion of 1 to 27 of that immediately outside of ours, would yet, even after allowing for great diminution before reaching the surface, be much more than is required by many terrestrial animals and plants. The reflection from his four moons, too, must at least make some small compensation, if any deficiency of direct solar light exist. Of this, however, there is no certainty, because the amount which reaches the planet itself depends on the absorptive and other qualities of the media through which the rays pass to it—qualities which differ entirely in their effects on rays of different periods of vibration. Both of these truths are well shown in the Earth's case, as by far the larger portion of solar rays is absorbed before its surface is reached, but in different proportion, according to their refrangibility and to the prevalence of certain atmospheric constituents; aqueous vapour and carbonic acid gas, for instance, being almost completely diactinic, *i.e.* penetrable by the more refrangible rays, while they hinder the passage of thermic ones.* And very recently it has been even proved that, under special circumstances, substances may absorb non-visual rays and give them out again transmuted into visual ones.† Still, as no modification of any of the kinds indicated can be proved .to exist; that the planet's atmosphere does differ in absorptive capacity in some way, is all that can at present be said, this difference being clearly indicated by the spectroscope. Of the planets beyond Saturn very little is known; but if we can see indications of a specific adaptation up to the extreme point cognizable, it is fair to presume that it extends further and involves the entire series. These indications are not wanting with respect to Saturn. He has belts which are sometimes almost as distinct as those on Jupiter, and obviously arise from a similar cause, namely, the combination of some external influence with the planet's rotation. There are, moreover, independent proofs of an atmosphere by the spectroscope. The most wonderful feature connected with him, however, is his system of rings, which, says Sir J. Herschel, "must present a magnificent spectacle, as vast arches spanning the sky from horizon to horizon," to the inhabitants, if there be any. How far they, with the eight satellites, make up by their reflection for any diminution of direct solar light cannot be said; but that they possess great, though not uniform reflective power, observations prove. A striking analogy has been remarked to Mars in the presence of a space around each pole, which varies in extent and brilliancy according to the seasons of Saturn's long year. Whether this results from the formation and melting of snow, or the accumulation of clouds, it would seem equally to indicate a variable atmospheric influence.

In many respects all the exterior planets resemble each other. They are all large, of low specific gravity, accompanied by more than one satellite, and have a nearly equal revolution, and but small inclination and orbital excentricity; so that, except as they are differently

* Dr. Miller in 'Journ. Chem. Soc.'
† 'Phil. Mag.' No. 192. 'Phil. Proc.' No. 71.

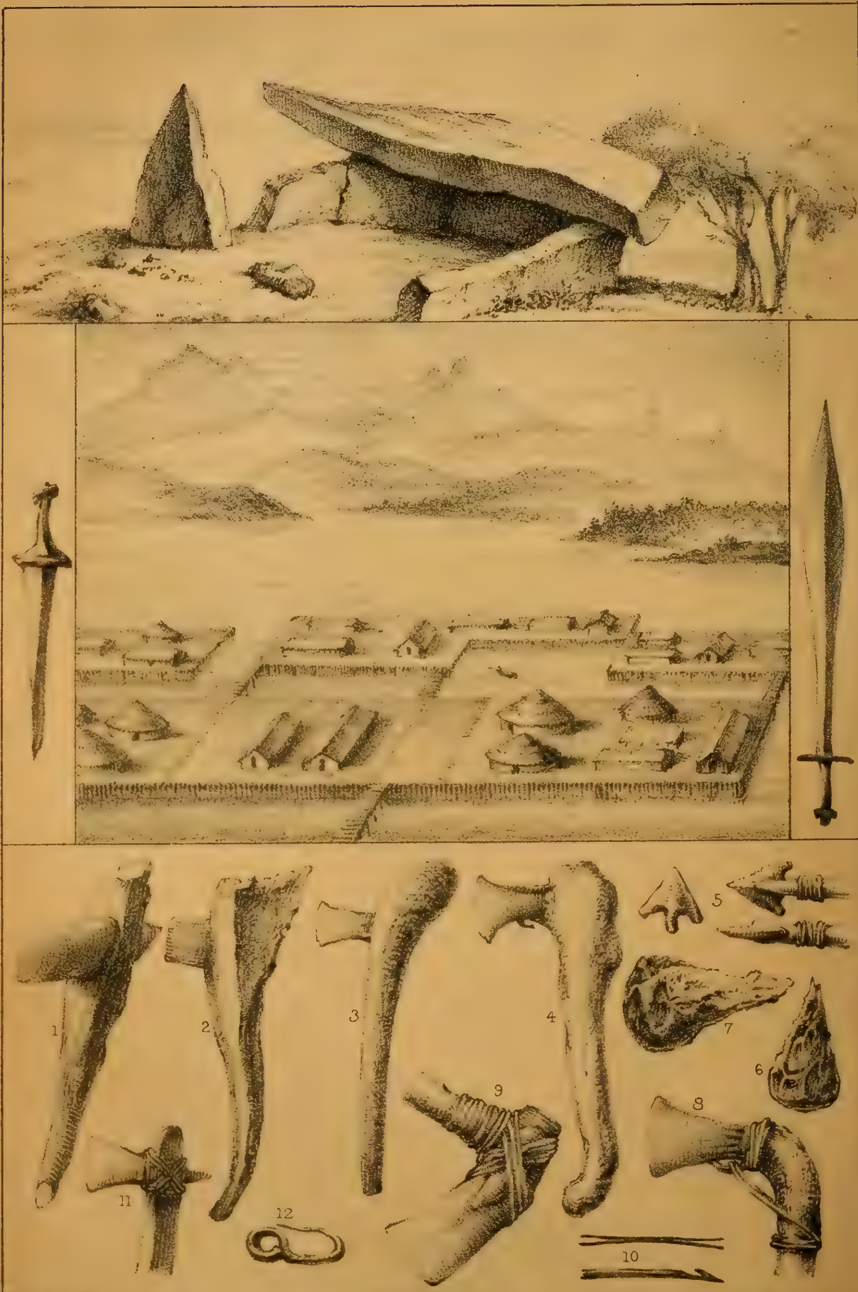
affected by their different distances from the sun, any conclusion arrived at concerning one of them would be equally applicable to the rest. With respect to heat, there seems clear evidence of a compensation for diminished solar radiation. The same cannot, however, as yet be certainly said of light. But even on the ordinary law of radiation, and not considering the small but appreciable effect from the four, if not more, moons of Uranus, and the two of Neptune, the amount of light at the distance of the latter must be far beyond the limits enjoyed by many terrestrial creatures. The light from brightest sunshine has been calculated by Wollaston to be equal at the Earth to 805,072 full moons, and as Neptune is thirty times more distant than it from the sun, he would receive $\frac{1}{900}$th the amount, or an equivalent to that of 890 full moons, if his atmosphere exerted the same absorptive effect as ours. The average day of the exterior planets is ten hours, their years varying in length from nearly 12 of ours on Jupiter to $164\frac{4}{5}$ on Neptune. The specific gravity, compared with that of the Earth, varies from ·24 for Jupiter to ·14 for Saturn.

Between Mars and Jupiter are from 75 to 80 small planets, of which more is unknown than known. We will merely observe that their aggregate mass is much smaller than their number would seem to imply, as Le Verrier concludes, from its producing no perceptible variation in the heliocentric longitude of the perihelion of Mars that it cannot equal one-third that of the Earth.*

On summing up this subject we find that on our own planet every element, every region, and nearly every foot of space swarms with living creatures possessing an endless diversity of organization to suit an endless variety of condition; that throughout all geologic ages "the systems of life have been varied from time to time, but never extinguished;" that from microscopic creatures only the millionth of an inch to the immense Dinotherium giganteum, or the Megalosaurus, seventy feet long, there has been every gradation of size; that beyond our planet there are evidences of adaptation, first on one and then on another member of the series to which it belongs, of a character such as to render them probably habitable; that, furthermore, there are indications of a great number of such series in the existence of bodies resembling the sun as independent sources of light, heat, and chemical and attractive power, and, like him, abounding in elements which, under the influence of these forces, seem specially susceptible of ministering to the organization of living creatures; that many of these greatly surpass our own sun in some of these qualities, their light being so intense as to penetrate to the base of our atmosphere, while themselves are often so distant as to afford no sensible parallax; that one of them at least is ascertainably of a much greater mass;† and, lastly, that their great distances from him and from one another would be explicable on the supposition that they had secondary systems revolving round them, which these distances preserved from destruc-

* 'Month. Not. Astro. Soc. for 1853 to 1855,' p. 63.

† The binary system, 70 Ophiuchi, is said by Sir J. Herschel on the authority of M. Krüger to be $3\frac{1}{10}$ times the mass of the Sun.



C.W.K. del. Hanhart, Imp^t Edwin M. Williams, Sc.

RELICS & RESTORATIONS OF THE STONE & BRONZE AGES.

tive perturbation. And in the face of all this it seems to require a great strain, from the effect of which the mind instantly recovers when the force is removed, to think that throughout all space life can be absolutely limited to one small globe.

PREHISTORIC RECORDS.

By the Rev. C. W. Kett, M.A.

In order to arrive at a knowledge of the condition of men in the early period to which we refer under the term Prehistoric, we have two sources of information — the one consisting of the *relics* of their arms, ornaments, utensils, habitations, and burying-places, raw materials, manufactures, and even bones, especially skulls, found in various places, in Kitchen-middens, Lake-dwellings, Burial-kists, and Barrows or Tumuli; the other being the traces in *language* of inventions, arts, pursuits, or possessions, which a diligent comparison of connected families of tongues leaves as a common residuum, and which, added to the comparison of mythology and law, go to make up the subject-matter of the now extensive science of Comparative Philology. Comparative Philology and Archæology, therefore, form the basis of the following paper.

The Prehistoric Age consisted of many periods of various, and, at present, of unknown duration. The principal of these may be arranged in the following manner:—The *Aryan Age*, when almost all the nations which are now settled over the broad face of Europe, in India, and through a large portion of the intervening tracts, formed one family, and dwelt in one small region somewhere between the Caspian Sea and the Himalayas: the *Age of the Dispersion*, which lasted whilst the scattered tribes roamed about the world in search of the habitations where they have since dwelt; the *Age of Stone*, when some early wanderers from the outskirts of the main portion of the nation having lost in their nomad life many of the arts which they possessed in the cradle-land of their race, or, more probably, some distinct race pushed forward by the advancing tribes of the Aryans, settled down in habitations somewhat fixed, employing the rudest and roughest of all materials—stone, for the production of nearly all their weapons, and even their domestic utensils; the *Age of Bronze*, when the metallurgic arts revived or were discovered anew, or perhaps even introduced by a new race, and an era of greater elegance and refinement once more broke upon the benighted intellects of the early inhabitants of this and neighbouring countries; and, lastly, the *Age of Iron*, which runs into the period of which we have some documentary account.

I must here guard against an ambiguity in the word *age*. By this is scarcely intended so much a fixed period of time, as a condition through which a nation has passed. Most of the nations of Europe, and probably of the whole world, have traversed these five stages,

but as the History of the Jews begins at a much earlier date than the History of Rome, and the History of England succeeds after a lapse of some hundreds of years, so it is scarcely possible to say that a Prehistoric Age of the Jews ever existed, whilst that of the South and of the North of Europe, of the Roman and the Teuton, extended to very different dates in the world's history. Other ages, too, besides those mentioned above will be referred to, such as the age of a particular kind of dwelling or mode of life, or, it may be, of a peculiar character of Flora in certain countries ; we shall have to speak of the periods of the Lake-Dwellings, the Kitchen-middens, the Fir, the Oak, and the Beech ; but these are neither co-extensive with the former, nor can they altogether be separated from them. With regard to these latter, we may say at once that Sir Charles Lyell,* on the authority of the Danish antiquaries, makes the Stone Age extend throughout that of the Scotch Fir (Pinus sylvestris) into that of the Oak, with which that of the Alder Birch (Betula verrucosa) flourished. The Bronze Age takes the remainder of the Oak, whilst the Iron corresponds nearly with that of the Birch. Again, some of these different ages may be contemporaneous — a Bronze Age in Britain might have existed at the same time as an Iron Age in Italy,† and probably an early Stone Age lasted in Britain whilst the Aryans still remained in their Asiatic home.

It would be impossible, in the space allotted to the present article, to give anything like a full account of the mode of procedure by which comparative philologists have arrived at a tolerably sure knowledge of the condition of the Aryan‡ race before it was dispersed over India and Europe. Comparative Philology reveals to us much concerning our ancestors. When we find words evidently common to all the nations descended from our forefathers, we can safely predicate that the idea represented by that word was known before the Dispersion.

Thus, if we observe that the Roman languages all contain similar names for many inventions and appliances of civilized life, we might deduce, even if we did not know it from other sources, that the Romans were acquainted with these inventions, and the elements of the appliances. In a similar way, many facts concerning the common ancestors of the Scandinavian and Hindoo may be deduced from the number of words possessed in common by their descendants. In the same way, the particular characters of any class of words will give us a clue to the history of a nation. If, for instance, the words referring to a particular branch of art or manufacture have all a foreign origin,

* 'Antiquity of Man,' chap. i and ii.

† A Roman historian (Polybius, I believe) speaks of the Gauls, in a battle during one of their early raids in Italy, straightening their swords by treading on them after a blow.

‡ The word Aryan has now been generally adopted to signify the race to which F. Schegel, in the early dawn of this science, gave the name of Indo-Germanic, which was afterwards extended to Indo-European. Erin and Iran, the native names respectively of Ireland and Persia, contain the root of this word Aryan, which is said to signify noble, and which is connected with that widely-diffused root AR to plough, from which we get the verb and the words ear, earth, arable, oar, &c., &c.

we may well deduce that art or manufacture was imported from the people whose words have been adopted to convey the idea represented. Several instances of this may be noticed, both known historically to have actually taken place, and also plainly deducible without such historical data.*

As in the languages of which we know the history we can confirm our knowledge by the testimony of words, so a comparison of the language, mythology, and law of the nations of the Indo-European or Aryan race has brought us conclusive evidence of which we may be sure that the general outline is true, though we may not be able to fill in the picture so thoroughly as we should wish. We find that at a time when this ancient nation dwelt in its first abiding-place, it was divided into divers tribes speaking various dialects; that it was first of all separated into two main streams—a northern and a southern; that as time went on, some overwhelming necessity, probably that which ever had and still has such an influence on the migrations of men —the desire of food — drove these tribes forward in various directions and at various times, now side by side, now chasing one another, like waves on the ocean—at one time parted by some insuperable obstacle, and anon reuniting with the clash of contending force, and then together again sweeping forward with increased energy over all barriers placed to oppose it.

But we want to see these nations as they once dwelt in their cradle-land.† Essentially pastoral, they differed at first but little from that other great race the Semitic, whose greatest leader had already passed westward over the river Euphrates. But, unlike him and his descendants for many generations, they were not nomadic. They dwelt not in the black tents of the Arab Sheik, Abraham the Hebrew, the Passer-over; but like him they possessed their flocks and herds, their sheep and goats, their oxen and horses,‡ their dogs, pigs, geese, and fowls.§ Their cattle, their chief wealth and sole standard of

* In this way the English names of many ecclesiastical services, garments, titles, &c., are of such Latin origin (or in some cases, Latinized-Greek form), that we cannot but remember that we owe our Christianity chiefly to St. Augustine and his Roman monks. Again, our military terms, as far as the words are ancient (many of the modern introductions are Italian or French, the former pointing to the bands of Italian mercenaries that overran Europe in the Middle Ages, the latter to our wars with France) are mostly derived from the Norman French. Our naval terms are of Scandinavian origin, whilst the terms of peaceful and agricultural employments are mostly Anglo-Saxon. In Latin we see something similar in the fact that most agricultural terms are nearly allied to the Greek, whilst the derivations of the military terms are harder to trace, pointing to the fact, probably, that the ancestors of the Romans were descended from two tribes, the conquering and dominant one not being so closely allied to the Hellenes, as the conquered and industrious class.

† The results given in these sections are principally taken from L. F. A. Maury's 'Histoire des Religions de la Grèce Antique,' Mommsen's 'History of Rome,' and A. Pictet's 'Les Aryas Primitifs.'

‡ The Jews were forbidden to use horses, and seem to have had none until Solomon's reign. The Arabs, too, are represented on the Nineveh sculptures as riding only on camels.

§ Geoffroi St. Hilaire says that there are forty species of domesticated animals, of these thirty-five are to be found in Europe, of which again thirty-one have

value (pecunia and fee), roamed not from pasture to pasture, but were protected by stables and enclosures. The rites of hospitality required the fatted calf for the stranger. The vine* had flourished since the days of Noah. On the daughters† of the tribe devolved the duty of milking and churning; and the products of their industry with flesh of the flock, which they could season with salt, formed the staple food of all classes, though barley, and perhaps other kinds of corn, and some vegetables, were not unknown. A little later, when the North parted from the South,‡ the plough was introduced, the oxen were yoked to it, and agriculture began to advance. The life was no longer exclusively pastoral; they sowed different sorts of grain, cultivated vegetables, planted the vine, pressed the olive in order to extract the oil: hence instruments had to be made, trades arose, a division of labour was begun. The carpenter had his knife, hatchet, auger, hammer, perhaps even a saw, but we know not of what material—stone, bronze, or iron. The distinction between these latter metals is not clear, but they possessed others—gold, silver, and tin, from all of which objects of finery were fashioned. Bronze was hardened by hammering and tempering; it was sharpened; and arms formed of it could be furbished; in working it the forge with bellows, pincers, hammer, anvil, were put in requisition.

By their knowledge of corn, as an edible product, they esteemed themselves advanced in civilization far above the barbarians, who, they supposed, existed on acorns and beech-nuts. Spinning and weaving wool and hemp and flax, were practised; needles and thread were not unknown. The art of the potter was developed in many directions, and his productions took their place beside the articles of wood and stone in the dwellings of these shepherds.

They did not dwell in tents like Arabs, nor in waggons like Scythians, but how their dwellings were constructed we know not; though that they were not the mere huts of savages, we may judge from the fact that they knew of doors, openings for windows, domestic hearths, and separate chambers for sleeping. These dwellings with their stables and enclosures, generally it is supposed stood alone, but villages, and even small towns encircled by a wall, were occasionally to be found. What the ordinary dress of that period might be we cannot tell, but we may well suppose that the golden finger-rings, torcs, bracelets, and neck-rings of a later time, were preserved from these early days, being less destructible than many more useful articles, and taking considerable time to acquire in the numbers,

their original habitat either in Central Asia, the Eastern coast of Africa, or on the shores of the Mediterranean in Southern Europe.

* The Hebrew word for wine יַיִן is closely allied to the Aryan-root of *Ϝοῖνος*, vinum, wine. Sans. vêna beloved, used in the Vedas for the ambrosial Sama. As yet no philosophic attempt has been made to compare the Semitic with the Aryan roots.

† Daughter, Sans. duhitar, the milkmaid. See M. Müller, in 'Oxford Essays, 1856.'

‡ The words now have their roots only in Sanscrit, the entire words are common to the northern nations of the Aryan family alone.

and with the amount of elaborate ornamentation that we find at a later date.

The sole wealth of this pastoral people consisted of cattle and slaves, with the few simple utensils referred to above; raids, we may well imagine, were not more uncommon than we find them at later periods, and accordingly we find that military terms are widely diffused. The warrior was armed with the lance, the javelin, the bow-and-arrow, sword, mace, battle-axe, perhaps the sling. He defended himself with a shield, but we cannot trace other defensive armour. Horses were yoked to chariots, but do not seem to have been used for riding. In fact, riding was an accomplishment acquired about the time of the early settlements in Europe, but shortly before we come to some trace of actual history. Instruments of music gave signals of war and encouraged the combatants. Little, probably, was known of navigation before the arrival of the nations at the Caspian, or even at the Black Sea or Hellespont.

Family ties were recognized and respected in this early condition of our race. The ceremonials common at marriage-festivals prove the importance attached to that event. Brothers, sisters, uncles, aunts, nephews, nieces, son-in-law, daughter-in-law, brother-in-law, and sister-in-law, each had their names and their position. Families increased into clans, and clans into tribes. The father developed into the chieftain; the chieftain into the war leader,—the king; and the heads of families into elders and senators; but the rights of the younger men, freemen and not slaves, were respected. Territorial possessions were fixed and bounded, property descended by inheritance; buying, selling, and exchange, were resorted to. Nor had life only a serious aspect. Besides the amusements of the chase, these early peoples cultivated music, dancing, poetry. The reed-flute and a stringed instrument were added to their martial music. Dice, and possibly some game like draughts, were the pastimes of the chiefs.

Of their religious feelings it is more difficult to speak. They seem to have recognized the soul as something to be distinguished from the mere breath of life. They had terms to express knowledge, will, memory, thought, and these abstract words were removed from their original concrete signification. It is clear that all abstract terms are derivable from sensuous ideas, but this step of derivation was made by the early Aryans. In their early realization of the abstract, no nation approached this race so early destined to be vigorous in philosophic culture and penetration.

A decimal system of notation, founded probably, as amongst most other races, on numeration by the fingers, was current before the Dispersion. The year consisted of 360 days, and was divided by the revolutions of the moon. The Great Bear* had received its name, though planets were not as yet distinguished from fixed stars. By the Milky Way souls were conducted to the sky. A tradition of a deluge that destroyed the human race was handed down, but their religion had become a polytheism, a worshipping of the powers of nature per-

* Max Müller's 'Lectures on the Science of Language,' 2nd series, p. 361.

sonified, still with a grand underlying belief in* one controlling Deity, God of gods and Lord of lords.

Such were the Aryans, as far as we can picture them to ourselves from the remains of their language. In such a sketch as this, however, we must guard ourselves against two sources of error: the one, that the absence of words representing ideas necessarily implies the absence of the idea; the other, that the presence of the same word in distinct branches necessarily implies the knowledge of the thing represented in the race before these branches were separated. In the former case it must happen occasionally that amid the phonetic attrition of ages, sounds have altered or become obsolete, so that but one tongue has retained any trace of the original denomination. Besides we have every reason to believe that in ancient tongues there were many words distinguished by shades of meaning no longer recognized, as in the case of the list of terms to designate the carving of various birds and animals as given by Lady Juliana Berners, most of which terms, though in use in the Fifteenth Century, have now become extinct. In various dialects one of these expressions might be used to designate the whole; in another, another. We should, in both these cases, have no basis for comparison, and though we could not be sure that the idea existed, we should have no right to say that it had not existed. On the other hand, where the word does occur in different languages we must ever guard against the possible introduction of the word into the one language from the other. Thus, in the Keltic and English (both Anglo-Saxon and Romance) there are many words which ardent Keltic scholars would fain claim as the inheritance of their favourite race, bestowed by them upon the intruders on their land, whilst Teutonic philologers, disdaining the elder race, sweep all into their own net. Too substantial a fabric, then, must not be built upon such doubtful foundations until we spread a wider surface to support the superincumbent mass. Here Archæology comes in, and together with tradition, scraps of History, and other relics of a forgotten world, helps us to shore up a tolerably substantial framework under which to collect, arrange, and turn to account the knowledge we may glean from all these quarters.

Of the Age of the Dispersion we know at present scarcely anything. A scattering of the nations must have taken place, because they were once united, and we now find them separated. We may imagine that hunger, the love of adventure, or the curse of Babel, drove them forth. Too narrow a country, a desire to see what was beyond their own happy valley, disagreement and misunderstanding with their neighbours, are all motive powers, potent in those days as they have been since. At some future stage in the history of science, it may be possible to trace to a certain extent their wanderings, now entirely shut out from our ken. All we know as yet is, that the ancestors of Greek and Roman remained united after they had broken off from the original stock; that the Keltic wave preceded the Teutonic over Gaul, Britain, portions of Spain, and Italy, whence it sent forth

* Max Müller's 'Lectures,' 2nd series, lect. 10.

armies to conquer Italy, Greece, and even Asia Minor; that the Teutonic, both Low and High German, traversed some portion of the road in common with the Scandinavian; that they then parted to meet at a future period, and to make this island their battle-field. Comparative Philology, one of the newest of the sciences, has told us much of an older age. Archæology, a very old study, has only of late revealed much that is new to us about a later period, perhaps some new science yet to be discovered, or at all events perfected, will tell us more of this transition state.

We must now leave for a time the Aryans as we have found them amidst the diversified country of West Central Asia. The successive migrations of nations have already more than once been compared to oceanic waves. Such a wave seems traceable previous to the dispersion of the Northern Aryans. Here and there on the coasts of Europe on narrow spits of land, defended by mountain ranges or by almost impenetrable cold, are to be found remnants of a race, once, it may be believed, numerous, now almost extinct. The Basques in Spain, and the Lapps* in Scandinavia, are supposed to be the last survivors of a family of nations that spread not only over those peninsulas, but over Denmark and these Islands, if not over almost the whole of Western Europe. Whether even they were the earliest human inhabitants of Great Britain is still a moot question.

The Stone Age is the earliest of which we have any remains, either in these islands or in Scandinavia. If any of the people of this period belonged to the Aryan family, during their wanderings from Central Asia our predecessors had lost most of the arts acquired during a settlement for some time in a country possessing a diversified surface and various capabilities. The period of which we are now speaking has been identified with that of the pine forests of Denmark, amid which the Scotch fir, now no longer known in that country, raised its massive head. No such peculiarity is known to have existed in the Flora of Great Britain, but many a wild beast, now unknown to us, some even extinct or verging on extinction, roamed through the forests as yet untouched by the axe of the woodman, sank into quagmires that never quivered beneath the footstep of man fearful of nature's wonders, or made its home in the cave that served for a dwelling-place, or the model of a dwelling-place to the biped, whose nature was but little raised above his quadruped competitors in the struggle for life. Traces of many of these extinct animals existed down to quite modern times. Many an animal has died out within historic times, and many more in the long ages that preceded this. Such a change as the introduction of man must have had an immense effect upon the brute creation.

As late as in the time of David the First of Scotland, beaver skins

* I know not whether the Esquimaux are supposed to be ethnically connected with the Lapps and Finns, but many of the peculiarities of the earliest of our predecessors have been compared to the present habits of these remarkable tribes, and one of the motives put forward as a reason for research in Arctic regions is that the habits of the people to be discovered there would probably throw much light on the condition and mode of life of our own remote ancestors.

formed articles of commerce ; wolves were not exterminated till after Alfred's reign in the more civilized portion of the island, and at this early time we find, besides all the still-existing deer and boar (the wild beasts *par excellence*, the Greek θὴρ and φὴρ, Lat. *fera*), the great fossil elk, the reindeer, the goat, three kinds of wild oxen, the auroch, or European bison, the brown bear, and the cave bear. Fiercer and more formidable than these again were the hyænas a rhinoceros, an elephant or two, it is said a mammoth, even a mastodon, a tiger, and another beast of the same family, larger and more terrible.* These had to be contended with by the early inhabitants of this island ; these they subdued, and in many cases devoured. But though such a diversity of animals stocked the land, food was not too plentiful. Either man feared to taste the unknown flesh of many of these quadrupeds, or he was unable frequently to master the larger or the fiercer among them, with the ill-made and clumsy weapons he then possessed.

A mere taste for shell-fish would scarcely explain the large heaps of their remains, principally those of periwinkles, but also whelks, oysters, and scollops, that have been found in many parts of Scotland, the Orkneys, Denmark, Scandinavia, and even the American coasts, did we not remember that flint-tipped arrows and stone axes and hammers would avail to kill but few deer, wild oxen, or wild horses, whilst sheep were scarce, and whales but seldom floundered into creeks or bays where they could be despatched by navigators of single-tree canoes (Einbäum), fashioned by stone axe and hollowed by fire. Wretched must have been the condition of these makers of the kitchen-middens (Kjöckkenmoeddinger), only to be compared in poverty, though contrasting grandly in endurance, with the grub-eating savages of Australia.

There is a great interval between the chipped flints found in earliest strata and the ground and polished celt or delicately-formed arrowhead (compare Figures 6 and 7 with 1 and 2) ; besides two distinct modes of burial, both evidently belong to the Stone Age ; and Dr. D. Wilson† thinks, that he finds traces of an earlier race, whose long, narrow, boat-shaped skulls denote a lower grade of civilization concurrent with these rougher implements. To these people he would attribute all the oldest and roughest remains of the Stone Age. The editors‡ of the 'Crania Britannica,' on the other hand, see no distinction so decided as to warrant division of this kind from the small amount of data as yet acquired. Where such authorities disagree, it is not for us to decide ; at the same time, we cannot help thinking, that the learned editors of the last-mentioned work have furnished almost evidence enough to confirm Dr. Wilson's theory, whilst the

* "In this island, anterior to the deposition of the drift, there was associated with the great extinct tiger, bear, and hyæna of the caves in the destructive task of controlling the numbers of the richly-developed order of the herbivorous mammalia, a feline animal (the Machairodus latideus) as large as the tiger, and to judge by its instruments of destruction, of greater ferocity."—Owen's 'Brit. Fossil Animals,' p. 179.

† Prehistoric Annals of Scotland.

‡ Messrs. J. Thurnam and J. D. Davis.

increase of skill in manufacturing stone implements would serve to confirm whatever evidence there might be. Of one fact there is but little doubt, that some of our predecessors in this island had a practice still common amongst some of the tribes of North America, *viz.* that of flattening the skulls of their children by compression during infancy.

There is, then, still something to be done in clearing up the early ethnology of this country. It seems clear, however, that some race, probably Turanian, dwelt here before the Kelts landed on these shores, but whether this previous race had themselves crossed the Straits of Dover or had migrated before the sea broke through to separate us from some of the turmoil of Continental strife, as has been adduced from the Flora of the period; or, again, whether they had been anticipated by an earlier race—that race which left its flint weapons at Hoxne, dwelt in numbers about Bedford, with a stone killed an elephant, where Gray's Inn Lane now stands, and dwelt in caves at Brixham,—we are not as yet in a position to state with certainty.

But to turn from the people to the remains of their productions: the earliest dwellings of all seem to have been natural caves; then holes artificially made; next after these, and in imitation of them, we find in Scotland underground dwelling-places formed of large unhewn stones without cement of any kind; these are called *weems*, from the Gaelic *uamha*, a cave. They sometimes consist of several apartments, being as much as 30 feet in length, and were evidently long dwelt in, from the amount of ashes and other remains left in them. They were roofed by causing large stones to rest on the sides, so as to lap over from the centre; and again, others were caused to project farther inwards, until they were sufficiently near for a single flag to bridge the interval. No nearer approach to the arch was attempted. Near many of these weems have been found circles of stone of some two or three feet in height, accompanied by stakes of hazel, probably used as the summer dwelling-places of the inhabitants of the subterranean cells during that portion of the year when the climate would allow them to escape the darkness, smoke, and listlessness below. Whether these circles were protections to tents or the outer rim of a species of wigwam, cannot now be determined; but we may well imagine the joy with which the cave-dwellers would leave their sunless, miserable holes for the upper air as soon as the climate permitted them to enjoy fresher air and more room.

But among habitations the Lake-dwellings (in German, Pfahlbauten, pileworks) are perhaps the most interesting. The remarkably dry winter of 1853–4 caused the lakes of Switzerland to sink far below their usual level. Some of the inhabitants of Meilen, on Lake Zürich, took advantage of this circumstance to enclose a portion of the land usually covered by the lake, but now left dry. In so doing, they used the earth on the inside of the boundary to make the embankment. In the soil thus used, they soon noticed the remains of many antiquities of some early race. This drew the attention of several learned men* to the spot, and in consequence of this, to like

* M. Aeppli was the first who recognized the value of these discoveries.

remains in other lakes where similar dwellings were soon discovered. These habitations beginning with the earliest portions of the Stone Age extend to the time of the Father of History in Greece, and even down to historical times in Switzerland.

Herodotus* speaks of a race of Thracians who dwelt on Lake Prasias,† who lived in huts constructed on platforms on the lakes. These platforms were originally constructed by the united labour of the community, but that after this every man on taking a fresh wife (and polygamy was common), was compelled to add three piles to the common stock. The labour of cutting, pointing, and then driving these piles, which are mostly of fir, but also of oak, birch, and aspen, when only stone axes could be used, must have been enormous. We find that at this early period the piles were small, not being more than 3 to 9 inches in diameter, but from 15 to 30 feet long, since the spot was usually so chosen that the water was about 20 feet deep. At Wangen alone upwards of 40,000 piles have been found.

In Switzerland, M. Troyon ‡ says the piles were usually arranged parallel to the shore at a distance of from 100 to 300 feet, and from one to two feet apart. On this common platform were constructed circular huts of wood, interlaced with branches and daubed with mud. Portions of this daubing, burnt probably in the destruction of the dwellings (nearly all these habitations seemed to have perished by fire), have been found at the bottom of the lakes. The curve that these pieces of burnt clay give would require a diameter of from 10 to 12 feet. Allowing a diameter of 15 feet, and as much space for means of communication as for dwellings, the platform at Morges on the Lake of Geneva, which is about 1,200 feet long by 150 broad, would have held 316 huts, and these, with an average of four inhabitants to each hut, would give a population of 1,264. A similar calculation for the Lake of Neuchâtel would have afforded security to 5,000 people, whilst the whole of Western Switzerland would have contained upwards of 30,000 during the Stone Age, and more than 40,000 in the Bronze Period. Beneath his dwelling each man had a trap-door, through which, says Herodotus of the race of whom he spoke, it was only necessary to thrust a basket and leave it for a short period, when it might be taken up full of fish. Fishermen say, that shade is so grateful to these creatures that this is quite possible, but it sounds rather like what our old author was told, than what he had seen with his own eyes. Fortunately for us these trap-doors, or the interstices of the beams, became the receptacles not only of a great deal that must have been considered rubbish, but of much also that was valuable to the owners as well as to modern antiquaries. From the site of only one of these dwellings have been recovered not less than 500 bronze hair-pins of an ornamental character, a fact that looks as

* Book v. c. 16.

† Now Lake Takinos, in Turkey. It has been stated in the 'Revue de l'Instruction Publique,' that the remains of these very dwellings have been rediscovered by a M. Deville.

‡ See Plate, and a translation of a paper by M. Troyon in the 'Ulster Journal of Archæology,' vol. vii.

if the hair they were intended to confine was often in a dishevelled condition.

It is hard to imagine why people should have chosen such localities as these lakes for their habitations. No doubt, safety, first from wild animals, and afterwards from their fellow-men, was one of the primary reasons. Herodotus mentions that the Thracians, to whom we referred above, remained safe from the attacks of the entire Persian army. These men, however, dwelt far out into their lake. The Swiss, on the other hand, seem never to have gone farther than three hundred feet from the land, whilst their general distance was about one hundred. This, however, would probably afford sufficient protection against flint-headed arrows or sling stones, though we could hardly suppose it would have availed much against the fire-bearing arrows such as the Persians could have used. In Syria certain Christians are said to have escaped from the Mahomedans by living in such dwellings. Thus these platforms have been made use of down to late and historic times, and even in Switzerland fishing-huts constructed on this principle, according to M. Keller, existed on the Limmat, near Zurich, as late as the last century.

It is one of the customs of the day to compare the growth of nations to the growth of the individual, to speak of the education of a race as we should of the education of a child, and to talk of mankind as a body passing through all the stages that each member of the whole human family travels over. We all know how children delight in water, how boating, swimming, and fishing form some of the especial amusements of young people; may it not be that in the childhood of nations, when the earth was young, and tribes wandered about in the wantonness and playfulness, and with not a little of petulant quarrelsomeness, of children, similar likings and tastes led these young nations to choose a dwelling in the midst of the waters?

In order that an idea may be formed of the numbers of these Pfahlbauten, a list is subjoined of the principal lakes in Switzerland, in which they have been found, with the numbers attached. It will be seen that the surface of the country inhabited by the people of this time lay in the richer, more fertile, and less rugged part of Switzerland, in a line stretching across from north-east to south-west, and lying to the north and west of the Bernese Oberland. In Lake Constance have been found 16 (all of the Stone Period only). Wangen 1 (S*), Lake Pfäffikon 2 (S, *viz.* at Robenhausen and Wauwyl), Lake Zürich 1 (B and S, at Meilen), Lake Sempach 1 (B), Lake Inkwyl 1 † (S), Lake Luissel 1 (B), Lake Moosseedorf 2 ‡ (S), Lake Bienne 7 (S) and 11 (B), Lake Morat 1 (B), Lake Neuchâtel 26 (B and S), Lake Geneva 24 (B and S), Lake Annecy, in Savoy 1 (B), and Missbaumen 1 (S). The inhabitants of the Bronze Period migrated rather farther south than their predecessors in the Stone Age, whilst the latter alone dwelt as far north as Constance and Wangen.

Another style of habitation, also a species of lake-dwelling almost

* (S) represents the Stone Period, (B) the Bronze.

† A league south of Wangern, near Soleure.

‡ Near Hofwyl.

as remarkable as the Pile Works, was the *Crannoge.* This word, originally signifying in Irish a wooden house, is used in that country to designate an island artificially raised above the surrounding water, protected by piles, and not unfrequently heightened by wooden platforms over a foundation of stones. On two of the Swiss lakes, Lake Bienne* and Lake Inkwyl,† remains of this kind have been discovered; and in Scotland, at Carlinwark Loch, Kirkcudbright, a similar discovery was made with the usual accompaniment of a single-tree canoe. These canoes were good-sized logs, felled by stone axes, and hollowed partly by the same means, partly by fire. They were blunt-ended, as may be seen from several discovered in Ireland, Scotland, and Switzerland. Crannoges have also been found in the Loch of Leyes, Kincardineshire; Lochriaben, Dumfries; Loch Doon, Ayr; Loch Winnock, Renfrew; Dhu Loch and Loch Quien, Bute; in several small lakes in Nairn and Galloway, and apparently at Duddingston Loch, Midlothian.

Frequent mention of such buildings is found in the Book of the Four Masters, and other early native chronicles of Ireland, and these numerous allusions seem justified by recent discoveries. Attention was first called to these structures in 1837; 150 cart-loads of bones were taken from one spot at Lagore, on Lake Gobham, in County Meath.

Since then nearly fifty others have been examined in the counties of Roscommon, Leitrim, Cavan, Monaghan, Limerick, Meath, Westmeath, Down, King's County, and Tyrone. The piles of these buildings were from four to nine inches in diameter, usually in a single row, placed in the form of a circle or ellipse, cut with a hatchet of some kind and interlaced with wattles, and sometimes mortised with cross-beams. The remains discovered in these situations show that they were in many cases inhabited during the early period designated by the Stone Age, though history and some of the relics betray that they continued to be used to a much later period. Sir Phelim O'Neill was besieged in one of the wooden islands on Lake Roughan, near Dungannon, as late as the time of the Civil Wars under Charles I., and he could not be dispossessed until boats were brought from Charlemont to enable the besiegers to approach the island. The earliest historical notice of such a dwelling refers, strangely enough, to the one first discovered of late years. In the same work of the Four Masters mentioned above, it is stated that the island at Lagore was plundered and *burnt to the ground* by a chieftain of Meath, A.D. 848. Most of these places exhibit traces of having been occupied for a long period. They are strongly fortified with wood and stone, and usually completely separated from the shore, though some have causeways remaining. To the same cause which led to the building of Crannoges in the Irish, Scotch, and Swiss lakes, we may attribute the early settlement

* At the Steinberg, near Nidau, in the northern part of the lake, there is a Crannoge of between two or three acres in extent belonging to the Bronze period. Rousseau's retreat, Peters Insel, and the little island close by it, owe their origin to this cause.

† Described by M. Morlot. This lake has a muddy bottom, entirely free from stone, except the rubble brought by human agency to make this Crannoge. The portions of pile still remaining are of chestnut, black and shining as ebony.

in troublous times of the isles in the Adriatic, by the Veneti. The defence was perfect against the style of the warfare of many succeeding ages, and the security of Venice did much to establish the independence and commerce of Northern Italy in the Middle Ages. We owe, then, to the inventors of the Crannoge, a debt of gratitude for much they could scarcely have anticipated.

Of the character of house or hut erected on these platforms it is not possible for us to say much. In the year 1833, Captain Mudge discovered in Drumkellin Bog, in Donegal, a log hut, which, from various causes, may be assigned to the Stone Age, though the latter period of it. This cabin was built of oak planking; it was twelve feet square and nine feet high, and though so low, it was divided into two stories of four feet each. The planks were formed by splitting trees, and one tree in most cases would make only two planks. The framework of the building was mortised together, and the roof was flat. A stone celt was found inside, which exactly corresponded to some of the cuts on the beams. Near this hut, which seems to have formed one of a palisaded village, were discovered a leathern sandal, a flint arrow-head, and a wooden sword, all of the same apparent age. From this we may conjecture that the earlier inhabitants of the Crannoges had dwellings which served for little better than sleeping berths. These are the principal styles of dwelling inhabited at this early period, and certainly the complaint cannot be made that we have servilely copied their architecture. An imitation of a Weem, a Pilework, or a Crannoge would assuredly appear like a novelty at the present time.

The weapons and implements of the Stone Age reveal to us the condition and civilization of the people of that time. Celts (Latin *celtis*, a hatchet) were made at first by chipping stone so as to form a rude blade, somewhat of the shape of a woodman's axe. As men improved upon their manufacture, or, according to some authorities, in the second period of the Stone Age, the stone was ground down so as to form a smoother edge, and for this purpose a harder and less brittle stone could be used.* How handles were fixed to these awkward implements may be conjectured from the Plate which accompanies this paper, and which shows how such tools are used by South Sea Islanders, and exhibits such handles as have been found.† That they were used for chopping wood we have evidence in the marks on the wood corresponding to the celt found beside it, and we may guess that such handy implements could not but be made available in war and in the chase. The stone (No. 6 in Plate) was found beside an elephant's bones, which was probably killed by it, beneath Gray's Inn Lane. In order to divide

* Messrs. Jahn and Uhlman state that at Moosseedorf they found Flint and Rockcrystal used in the earliest period, whereas afterwards serpentine, gabbro, jasper, agate, and opal occur.

† The celts probably were more easily injured in the using than the handles, whilst the latter were made of materials sooner destroyed by time. The plate contains very nearly all the handles that have been discovered in Europe, except the one in the British Museum, though the number of celts is almost innumerable.

the stone, these poor savages seem to have had saws made of chippings of flint stuck in the slit of a wooden knife-like handle. Some stones marked with grooves such as would be made by these primitive saws, are to be seen in the British Museum. Flakes of flint were also used for tipping arrows and lances, and these, in time, were manufactured with great delicacy, so as to present barbs to add to their destructive power (*see* Fig. 5). Stone hammers and mullers are found in considerable quantities, and seem to have been employed long after the metals were introduced into finer works. Some of the later of these hammers and axes are pierced with holes for the reception of a handle, a refinement not attempted in the earlier stages, when they frequently had a groove for catching a withy or cord to clasp the head. Querns, or small hand-mills, appear with the earliest remains, and thus prepare us to find corn amongst the relics of this primitive people at the bottom of the Swiss Lakes. These querns have not disappeared very long from use in remote parts of Scotland.* We should not be greatly astonished to find one in use even in the present day in such localities as those in which spinning-wheels are still employed, which latter invention dates back to the same period, as is testified by the *whorls* frequently brought to light, and by the remains both of *nets* and of rough material made by some process analogous to weaving. Needles, pins, bodkins, awls, fish-hooks, and various productions of a like character, were made from the bones of various animals, which were first split, in order that the marrow might be extracted, and were then manufactured into articles of various shapes, some so remarkable that it is difficult to imagine their uses. We can only wait to see whether the savages at the North Pole, or elsewhere, possess similar implements. A curious cup was found in the Orkneys, fashioned from the vertebra of a whale.

Stone formed the material of which some of the domestic utensils also were constructed; for instance, plates of slate have been found, as well as chafing-dishes, ladles, two carved cups (like queches, used now for whisky), bowls, and what can only be described as a tureen of stone; but pottery was not unknown, though of the roughest kind, and it was but partially burnt, fashioned and ornamented only by the hand with the thumb-nail, without the assistance of a wheel. Ornaments of bone, fish shells, ground down so as to form rings, amber, coal, and beads of a variety of stones, have been found in some of the tombs, showing traffic or importation from a considerable distance in some instances. Wood was also used for heavy beetles, &c.

Whilst speaking of the implements used by the people of the Stone Age, it is only right to mention that several circumstances in historic times point to an early use of such instruments. In many instances we find stone axes and knives used in sacred ceremonials, where naturally we may imagine that an antiquated state of civilization was

* In the reign of Alexander III. of Scotland, A.D. 1284, the following law was passed against querns:—"No man sall presume to grind quheit, maishlock, or rye with hands mylne, except he be compelled be storm or be lack of mills quhilk sould grind the samen."

kept up. Thus Zipporah and Joshua both used a stone for circumcision, pointing to a strong probability in favour of the use of stone in the days of Abraham. Hannibal * used a stone wherewith to crush the head of his sacrifice on a very solemn occasion—again a Semitic race using this weapon. The priests of Montezuma,† when America was first explored, employed the same material for sacrificing, though metals were well known and in constant use for ordinary circumstances. In like manner we read that bronze implements and utensils were used by some of the mountain tribes of Kurdistan in the time of Xenophon,‡ as they still are by certain African nations.

Of burials, there seems to have been various modes during the one division of time which has been called the Stone Age. At first the body was placed in a small cell in a crouched attitude, the knees supporting the chin and the hands crossed on the breast or hanging at the sides. After this, and probably by a different nation, the body was burnt and the ashes enclosed in urns. A third period, which seems to commence with the Bronze Age, is characterized by burying the body at full length, a practice continued ever since its introduction in this island. Coffins were frequently of oak. They are sometimes made of a tree split and hollowed, the roughness of the splitting affording a means of fastening on the lid. The usual tomb during the first of these periods was what was called a kist (*kist-vaen*, Gael. stone chest), a small chamber of rough, unhewn flag-stones. Not unfrequently several kists were placed together, forming what has been called the Chambered Barrow, of which some very fine specimens were opened by Sir J. Colt Hoare, in Wiltshire, during the last century. The cairn of stones piled around the body is a very early style of monument, sometimes intended as a mark of honour, sometimes of dishonour. A heap of earth would naturally be connected with this monument, either in the form called the Long Barrow, like a gigantic grave, or the Bowl Barrow, resembling an inverted bowl, or the Bell Barrow; in some places, especially in Scotland and the Orkneys, a Conoid Barrow. At a later period stones were placed on the top and around the barrows, thence named Crowned and Encircled Barrows. These are common in Scandinavia,§ and probably were introduced into this country from thence. Of a similar date are the Twin Barrows, where one vallum encloses two mounds, usually of different sizes.‖

* Livy, lib. xxi. c. 45.

† The Mexicans used many instruments similar to those of our forefathers. Their mode of fixing the heads of their hatchets to the handles shows this. Clavigero says, "The Mexicans made use of an axe to cut trees, which was also made of copper, and was of the same form with those of modern times, except we put the handle in the eye of the axe, while they put the axe in the eye of the handle."

‡ Xenophon, Anab. lib. iv. 1, § 8.

§ Numerous and remarkable instances of these forms are given in N. K. Sjöborgs 'Samlinga för Nordens Fornalskare.'

‖ Stukeley gave the name of Druid Barrows to those which contained jet, amber, and glass beads, cups, &c.; but these seem to have belonged to females, and not to deserve separate classification.

Some of the Scandinavian barrows are marked out in strange shapes by rough blocks of stone, placed sometimes in geometrical figures, more frequently in the figure of a ship, with rowers, benches, masts, &c. These would indicate a similar taste to that of the later inhabitants of the same peninsula. It is not unlikely that many of the *things* or parliaments were held in these enclosures.

It was said before that the inhabitants of the Stone Age either had forgotten the use and manufacture of metals in their dispersion, or had belonged to a race outlying the family of Aryans, and were unacquainted with the arts of the great Indo-European nations. Suddenly the metallurgic art revived, and with it a higher condition of cultivation and of taste. Immediately upon the Stone Age we come to a Bronze Age. Here and there * a few pure copper implements are discovered, but these are scarcely sufficient to warrant a belief of a general Copper Age ever existing throughout Europe.† The introduction of bronze, then, is most interesting, especially to Englishmen, since we know of no source whence one of the component parts of this alloy,‡ tin, could have been procured, save the early wrought tin mines of Cornwall. On the Continent the Bronze era is supposed to have begun with the immigration of a new race. The Northern Archæologists believe that bronze marks the handicraft of the Kelt. No such change is observable in Britain.

In the midst of the Stone Age we have seen that a great improvement in the mode of manufacturing implements accompanied a difference in the conformation of the skull, and from that period on to the times of the Anglo-Saxons no great diversity in the shape of the cranium is observable. It seems probable, then, that in the first period of the Stone Age a cymbecephalic race, akin to the Basques, Lapps, and Finns, dwelt in this island or in some portion of it; that a Keltic race, the first wave of the Aryan family, passed over from the Continent armed with better-made stone § weapons and endowed with greater capabilities of improvement, and, according to the hateful theory of modern colonizers, when the superior civilization met the inferior, they "improved the former off the face of the earth;" that these Kelts procured by some means, either by contact with Phœnician or Iberian immigrants, or some local tribe, of which we have now no

* In the Museum of the Royal Irish Academy, several specimens of copper celts are collected. See the Catalogue, edited by Sir W. R. W. Wilde. It is not unlikely that the Copper Age may have existed longer in Ireland than in these islands, where tin is so abundant.

† In North America, a Copper Age lasted a considerable time. This was owing to the immense stores of native copper to be found on the shores of Lake Superior. The Indians could fashion this copper with their stone hammers without any knowledge of metallurgic arts properly so called.

‡ The ancient bronze is always of certain fixed proportions of *tin* and copper. Zinc seems to have been unknown for long ages afterwards.

§ The Kelts, we must imagine, had lost during their migrations the whole practice of the metallurgic arts known to the entire family when in Asia. This was almost a necessity from their wanderings, though the traditions, and, to some extent, the knowledge of the working of metals in a rude manner had not been completely forgotten.

trace, dwelling about the Cornish mines, or perhaps by some revival of the old metallurgic arts that they had half forgotten, the metals from which they formed arms of far greater power and beauty than they had hitherto possessed, and with the accession of strength which these gave them, some portion of the tribe returned to the Continent reinvigorated; they infused fresh spirit into Northern Gaul and conquered the Cimbric, and then the Scandinavian, peninsulas. This seems a probable explanation of some facts which it appears otherwise difficult to connect.

We may believe, then, at all events, with regard to our own island, that the Bronze Age brought no new race, and we may be prepared to find that no immediate variation took place in style of dwelling or of tomb, nor even in the implements of warfare and of industry, any further than the introduction of a useful and at the same time expensive material, caused a general improvement in all the comforts and exigencies of life. The stone celt formed at first the model for the metallic, but gradually, step by step, appliances, not producible with the old material, were introduced. A thin flange of metal to secure the blade to the handle converts the celt into a palstaff. A loop of the metal (as in Fig. 8) serves to give the gut or tendon a firmer purchase in tying on the shaft. At last the celt was made hollow to receive a staff in its socket.

Bronze swords must have been very different weapons from anything that preceded them, as only bone could have been used for this purpose before. In many cases we find these of great elegance (see Plate); the blade was in the shape of the spear-wort leaf, tapering towards the hilt, bulging as it nears the tip, adding, as beauty implies utility, weight to the point of percussion. The potter's wheel soon came into fashion, the ware was better baked; attempts were made to imitate natural objects in the decorations, and regular mechanical ornamentation took the place of the old thumb-nail pattern. Needles could be made more delicate, ornamental hair-pins and brooches were more finely wrought, netting and even crochet were not unknown; fruits, such as apples * and plums, were split and dried for winter use. These were some of the improvements observable in the Bronze Age. A careful study of the relics in the British Museum, and the Plates in the Papers of Drs. Troyon and Keller, and in the Catalogues of the Royal Irish Academy Museum, of the Museum of Northern Antiquities at Copenhagen, and in Lindenschmidt's 'Heathen Antiquities,' would well repay the trouble it might occasion, by the clearness with which it would bring the condition of our ancestors before us.

Concerning the Iron Age, less need be said than about the former periods. We are now verging closer on history.† On the Continent

* In the last No. of the 'Quarterly Journal of Science,' p. 85, will be found a list, prepared by Professor Heer, of the plants discovered in connection with the Swiss lake-dwellings.

† It has been supposed by some of the Northern antiquarians that in Norway, where iron is so abundant and in a form easily worked (magnetite ore accompanied by common fluxes) that an Iron Age, to which no relics have as yet been definitely assigned, preceded the Bronze era.

it is said that everything of iron manufacture bears an impress, more or less distinct, of the influence of Roman civilization. We know not whether the same may be true of England or not; but it is certain that iron was in use, though tolerably scarce * and valuable, at the time of Cæsar's invasion. The perishable nature of this metal has prevented many articles manufactured of it from being preserved to our day. We consequently are less acquainted with this Age, so far as it is prehistoric, than with those that have preceded it. The introduction of iron, like that of bronze, was of course gradual. In Denmark bronze axes with iron edges, and in Scotland a bronze spear head with an iron core mark this stage. Two distinct differences are to be marked as coincident with the introduction of iron. As with bronze we find golden ornaments, so with iron do we find for the first time silver used for articles of decoration. And again, as with the introduction of a new race, or the development of a new stage of civilization in the Stone Age, we first come upon the use of cremation and funereal urns, so at this new stage we observe a return to the old mode of *burying* the dead out of their sight; but not as formerly in a couching posture, but at full length. The man returns not to the womb of his mother-earth to be again absorbed into her substance, but he lies like a warrior taking his rest, awaiting the trumpet that shall again summon him to perform his duty much as it had been performed here, either renewing the conflict as of old or sharing in some way the triumph for victory won.

These are the principal divisions of the Prehistoric Times, as far as science has as yet been able to decipher the records of these early races from the language, the antiquities, and the monuments of much that is anterior to all written records. Whether further researches will tend still more to subdivide these we know not. Within the last few years much has been revealed. The Swiss *savans* are on the alert, the Danish and Swedish archæologists are translating Sagas and rummaging kitchen-middens and cromlechs, our own antiquarians are not a whit behind, but flock to every new discovery, comparing, measuring, and describing with an accuracy and a care which must in the end produce some considerable result.

We append a classified table of the Fauna of the Swiss Pfahlbauten, taken originally from Rutimeyer's monograph on that subject, and enlarged by Lubbock from other works of the same author. It shows the wild enemies with which these early people had to contend, and also exhibits how far they had subdued these enemies and turned them into useful assistants.

* "Nascitur ibi. . . . regionibus in maritimis ferrum sed ejus exigua est copia." —Cæsar, De Bell. Gall. lib. v. c. 12, § 5. Herodian speaks of the Britons wearing "iron about their stomachs and necks, which they esteem as fine and rich an ornament as others do gold."

Rutimeyer's Table, enlarged by Lubbock.

		Stone.				Bronze.			Iron.
		Moosseedorf.	Wanwyl.	Robenhausen.	Wangen.	Meilen.	Bienne.	Concise.	Auvernier.
1. Brown Bear	Ursus Arctos	2	.	.	2	+	.	+	.
2. Badger	Meles vulgaris	2	2	1	.	+	.	+	.
3. Martin	Mustela foina	2	3	.	.	.	.	(×)	.
4. Pine Martin	„ Martes	2	3	.	.	1	.	(×)	.
5. Polecat	„ putorius	2	2	+	.	.	.	.	.
6. Ermine	„ Erminea	.	2	.	.	.	.	.	.
7. Otter	Lutra vulgaris	1	.	+	.	.	.	.	.
8. Wolf	Canis Lupus	.	1	+	(×)	+	.	+	.
9. Fox	„ Vulpes	3	3	1	1	(×)	.	.	.
10. Dog	„ familiaris	2	2	2	2	3	3	(2)	+
11. Wild Cat	Felis Catus	2	2	+	.	.	.	.	.
12. Hedgehog	Erinaceus Europæus	1	+	+	.	.	.	.	.
13. Beaver	Castor fiber	3	2	.	.	.	.	(×)	.
14. Squirrel	Scuirus Europæus	2	2	.	1	.	.	.	.
15. Marsh Boar	Susscrofa palustris	5	5	5	5	5	2	(×)	.
16. Wild Boar	„ ferus	2	2	2	.	.	.	.	.
17. Domestic Hog	„ domesticus	.	1	.	.	.	3	+	(×)
18. Horse	Equus Caballus	1	2	.	1	2	3	.	.
19. Elk	Cervus Alces	1	1	2	.	2	1	(×)	.
20. Stag	„ Elaphus	5	5	5	5	5	5	(×)	+
21. Roe	„ Capreolus	4	2	2	2	2	.	.	.
22. Fallow Deer	„ Dama	.	.	.	.	(×)	+	.	.
23. Ibex	Capra Ibex	.	.	.	.	1	.	.	.
24. Goat	„ Hircus	2	2	2	.	.	3–4	(×)	+
25. Sheep	Ovis Aries	.	1	2	.	(×)	3–4	(×)	+
26. Urus	Bos primigenius	1	+	2	.	.	.	+	.
27. European Bison	„ Bison	.	1	.	.	.	.	.	.
28. Ox	„ Taurus domesticus	5	5	5	5	5	5	(×)	+
29. Kite	Falco milvus	.	.	1	.	.	.	.	.
30. Goshawk	„ palumbarius	2	1	.	.	.	.	.	.
31. Sparrowhawk	„ Nisus	2	.	.	.	.	.	.	.
32. Ringdove	Columba Palumbus	1	.	.	.	.	.	.	.
33. Wild Duck	Anas Boschas	3	1	.	.	.	.	.	.
34. Garganey	„ querquedula	2	.	.	.	.	.	.	.
35. Heron	Ardea cinerea	2	.	1	.	.	.	.	.
36. Fresh-water Tortoise	Testudo Europæa	1	.	.	.	.	.	.	.
37. Edible Frog	Rana esculenta	3	2	+	.	.	.	.	.
38. Salmon	Salmo salar	1	.	.	.	.	.	.	.
39. Pike	Esox Lucius	3	2	.	.	.	.	.	.
40. Carp	Cyprinus Carpis	2	.	+	.	.	.	.	.
41. Bleak	„ leuciscus	1	.	.	.	.	.	.	.
42. Mouse	Mus sylvaticus	.	.	1	.	.	.	.	.
43. Hare	Lepus timidus	1	.	.	.	.	.	.	.
44. Chamois	Antelope rupicapra	.	.	+	.	.	.	.	.
45. Domestic Ox									
46. Ass									

Rutimeyer's Table, enlarged by Lubbock—(continued).

		Stone.				Bronze.			Iron.
		Moosseedorf.	Wanwyl.	Robenhausen.	Wangen.	Meilen.	Rienne.	Concise.	Auvernier.
47. Golden Eagle .	Aquila fulva . . .	.	.	1	.	.	.	.	.
	„ haliætus . .	+	.	.	.	.	.	.	.
48. Owl . . .	Strix alves	.	.	.	.	.	.	1	.
49. Starling . .	Sturnus vulgaris . .	.	.	1	.	.	.	.	.
50.	Cinclus aquaticus . .	.	.	1	.	.	.	.	.
51.	Tetras bonasia . . .	.	.	1	.	.	.	.	.
52.	Ciconia alba	2	.	2	.	.	.	.	.
53.	Fulica atra	.	.	1	.	.	.	.	.
54.	Larus	.	.	1	.	.	.	.	.
55. Swan . . .	Cygnus musicus . .	.	.	1	.	.	.	.	.
56. Wild Goose .	Anser segetum . . .	.	.	1	.	.	.	.	.
57. Perch . . .	Perca fluvialis . . .	.	.	1	.	.	.	.	.
58.	Scardinius erythropthalum	.	.	1	.	.	.	.	.
58.	Chondrostoma nasus .	.	.	1	.	.	.	.	.
60.	Lota vulgaris . . .	.	.	1	.	.	.	.	.

1 signifies a single individual,
2 „ several.
3 „ species common.
4 „ very common.
5 „ great numbers.
× „ a trace.
+ „ added by Lubbock.

EXPLANATION OF PLATE.

At the top of the Plate is a Swedish Cromlech taken from a drawing in Sjöborgs Samlingar för Nordens Fornalskave. This is similar to many in this country which are sufficiently well known.

The view in the centre is taken with some modification from a conjectural restoration of the Platform of a Lake-dwelling at Wauwyl, on Lake Pfäffikon, in Switzerland, by Dr. Ferdinand Keller, and published by him in the 'Proceedings of the Antiquarian Society of Zurich.' A corresponding view from an earlier paper by the same author forms the frontispiece to Sir Chas. Lyell's 'Antiquity of Man.'

The figures on each side of this view represent a bronze sword and dagger.

1. Stone celt with wooden handle, apparently of pine, 13½ inches long, found in County of Monaghan. From Sir W. R. W. Wilde's Catalogue of the Museum of the Royal Irish Academy.

2. Stone celt with bone handle, copied from Linderschmidts Altherthümer unserer heidnischen Vorzeit. About 8 inches long.

3. Stone celt with wooden handle, from Little Fish River, in Africa. From Wilde's Catalogue.

4. A bronze celt with handle, found in the Boyne, near Edenderry. 13¾ inches in length. This is the only instance as yet discovered of a metal celt with handle.

5. Flint arrow-heads, found in Robenhausen and Geisboden (1846), showing the mode of attaching them to the shaft. F. Keller.

6. Flint implement, found near the skeleton of an elephant under Gray's Inn Lane.

7. Flint implement, from the valley of the Somme.

8 and 11. Restorations showing the probable mode of affixing bronze celts to handles. From Wilde's Catalogue.

9. Stone implement, used as an adze by Pacific Islanders. From Squier and Davis, Ancient Monuments of the Mississippi Valley.

10. Bronze needles, apparently for crochet and netting. From Swiss lake-dwellings. Keller.

12. Bronze brooch from Swiss lake-dwellings, approaching in shape to modern safety pins. Keller.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The events of the past few months in the agricultural world have belonged rather to the business than to the science or the art in which we are interested. The cultivators of light barley-growing soils have been excited by the probability, or rather the possibility, that the malt tax, which they believe to injure them, may, by a strenuous agitation for its removal, be reduced or taken off; and the cultivators of the clay-land districts of the country have been roused to something like indignation by the orders of the Home Secretary forbidding the travelling upon highways of the locomotive engines by which steam cultivation—so beneficial to their stiff wheat-growing soils—is accomplished. These have been the two chief topics of the agricultural newspapers, and neither of them is quite adapted for discussion here.

Beside these, some discussion has also arisen on other matters, rather, however, of social than of strictly scientific interest.

The Society of Arts has been at work through its committee, upon the Cottage-building difficulty — inquiring into the causes which retard the erection of houses for labourers in rural districts. And the English Agricultural Society has been engaged through a Committee of its Council, upon the subject of Agricultural Education. The idea entertained by some of the leading members of the latter committee seems to have been, that agricultural education means simply the education of farmers' sons; and that all the Society can undertake is to offer prizes for boys, the sons of farmers, who shall take honours at the local University examinations of middle-class schools. The results of professional education they declare incapable of being ascertained, or tested by examination—than which nothing can be more mistaken. It is perfectly easy to ascertain in this way the extent of any one's professional knowledge; and whatever immediate resolution may be pronounced by the Council, it is not likely that the general body of members will, in the long run, acquiesce in the proposal to throw the influence of a merely professional society into the great sea of general middle-class education, where it must be altogether lost. They will insist on limiting the efforts of the Society to the field of professional education, where the guidance and incentive of its examinations and rewards would be most effective.

There is yet another subject to be named in an agricultural review of the past quarter. The agricultural utilization of town sewage has been the subject of a paper from Baron Liebig, and of lectures before both the Agricultural Society and the Society of Arts. The conclusions to which practical agriculturists arrive on a consideration of this subject, are so opposed to those of the distinguished German chemist, that were it not for the sanction which they receive

from the best chemists of our own country, the practical farmer might very well hesitate to maintain the judgment he had formed. We do not pretend to a discussion here of the elaborate chemical report on this subject, which Baron Liebig has addressed to the Lord Mayor of London. But even the intelligent agriculturist can perceive one or two defects which it exhibits as a specimen of sound reasoning. In the first place, it evidently abandons the true Baconian philosophy in the method by which it professes to determine the composition and the value of the article it discusses.

The proper way to determine the composition of town sewage clearly is to obtain a fair and average sample of it, and subject it to analysis. Liebig, however, arrives at its value, not by examination, but by reasoning. He considers the food that is consumed in the Metropolis—the waste attendant on the cooking of so large a quantity—the average waste of the digestive process in adults and children —the quantity of urine and fæces voided by animals in the streets; and assuming that a certain proportion of all this will reach the sewers, he concludes what sewage is from what he thus believes it ought to be. This, however, is clearly not the sound or philosophical way of determining the point on which the whole of his subsequent reasoning rests.

Again, the reader of his report can hardly fail to notice a remarkable inconsistency in his valuation of the fertilizing powers of guano and of sewage water respectively. Guano he makes out to be agriculturally worth only 7*l.* 14*s.* per ton — a conclusion entirely upset by the actual fact, for the agricultural experience of the value of guano is large and long enough to make it certain that the market value, 12*l.* or 13*l.* per ton, is not more than agriculturists find it to be their interest to give. But the method by which he reaches so remarkable a result—namely, a discussion of only the ready-made ammonia, along with the phosphoric acid and potash which it contains, does not bind him when he values sewage-water. The urea, with its "potential" ammonia, as Dr. Ure called it, goes for nothing in the case of guano—but is all calculated, in the 7 grains per gallon allowance, at its full ammonia power in sewer water; and this is an inconsistency which must certainly diminish the influence of the paper published by the Baron on this subject. The practical agriculturist, moreover, who judges of the conclusion which it indicates, by his experience in the field, will certainly refuse his acquiescence. The ideas which it teaches, that the agricultural value of a manure can be determined anyhow but in the field—that the material put into the land in dung will all reappear in the consequent increase of the crop —that arable cultivation offers the best circumstances for the full realization of the fertilizing power of sewage, are all utterly opposed to the experience of the farmer. And, of course, the experience of the farmer must, after all, be conclusive on this subject. Once get the agricultural verdict, and it must be final—it is necessarily the true one. Whatever may be the prepossessions of the man of science there can be no appeal. Hence it is, that if we can show how the analogy of agricultural experience bears upon the sewage question, and, still better, if we can quote the records of actual agricultural ex-

perience of sewage elsewhere, in illustration of the treatment of the sewage of London, we shall have then obtained the only safe guide through the difficulties which surround the subject. And this was what, in the lectures before the Society of Arts and the Agricultural Society of England, was attempted. It was, indeed, subsequently alleged that the analogy of agricultural experience does not lead to the conclusion that it is the best policy to put sewage on grass land in quantity, as in a water meadow. It was declared that the farmer puts on his manure sparingly, carefully calculating how much the crop will pay for, and not applying more. But if agricultural experience proves anything, it proves that plants must be treated according to the nature of them. A rapid succulent growth, which is what we want in grass, is obtained by excessive manuring. The London market-gardener applies 60 to 80 tons of solid dung per acre to the cabbage crops of a single year. And it is perfectly consistent with this that the grower of a single acre of Italian rye grass, where succulent growth is also wanted, should put 10,000 tons of sewage on it in the course of a single year. But we are not dependent only on analogy to guide us here: they have for years and generations been putting 10,000 tons of sewage per acre over many hundred acres of poor land near Edinburgh. Here is a case which, as it seems to us, fairly closes the door on any further discussion. If ever there was a satisfactory and conclusive piece of agricultural evidence on the subject it is this—350 acres in extent, and 100 years in duration—it is altogether unassailable. By the use of sewage in quantity, these 350 acres are made to keep 2,000 cows during the season of growth. They must yield 50 tons of grass per acre to do it, or a ton of grass to every 200 tons of the stuff poured on. This, however, the advocates of minimum dressings declare to be a poor result. All we know is, that there is nothing like it anywhere else in England; and taking the character and continuance, as well as the quality of the produce into account, we do not suppose that there is anything like it anywhere else on the face of the earth. Add to this result that which Mr. Lawes observed at Rugby, where the produce was found to be in almost direct proportion to the quantity of the application, and the argument in favour of abundant dressings appears to be irresistible.

The whole discussion clearly shows that the best chance we have of turning the drainage water of our towns to a profitable agricultural account, rests on the plan which has succeeded at Rugby and at Edinburgh, where enormous quantities of dilute sewage, already in a putrid state, are poured over a comparatively small area of grass land, whose plants, both by leaf and root, feed and flourish on the ready-made food which is thus continually passing by them. We do not doubt that by-and-by the sewage water of London will be poured over grass lands in Kent and Essex—perhaps over the Maplin Sands, which Messrs. Napier and Hope propose to embank from the sea for the purpose; and, producing there at the rate of a ton of grass to every 200 tons or thereabouts of the filthy water utilized, we shall thus have food for an immensely increased herd of cows; and the elements of London sewage will be re-arranged in the more wholesome form of London milk.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

It has long been a matter of some doubt whether any perceptible disc could be observed where stars of the first magnitude were examined under very high powers in large telescopes. In most works attention is given to the *apparent* diameters of these stars, and the importance attached to the measure of this amount is daily felt in practical astronomy, and in particular in the determination of the parallaxes of stars. The most illustrious astronomers have occupied themselves with this question, and Sir W. Herschel has devoted to it several memoirs. According to this astronomer, the most delicate measurements did not perhaps give an apparent diameter to *Arcturus* exceeding the tenth of a second. This unexpected result agreed, however, with the observation of J. Cassini, who had observed, in 1720, the occultations of γ *Virginis*, and had concluded that the space between the two stars was thirty times greater than the real diameter of each of the components of this binary group. Until the present time these two celebrated observations have remained as the most characteristic types of the smallness of the apparent diameters of the stars; but since this epoch the progress in the means of sounding the distant regions of space has given the astronomer gigantic acromatic telescopes wherewith to repeat these observations. Moreover, although the method of occultations is preferable to all others, yet, as our satellite does not cover by its movement in the celestial sphere the most brilliant of the stars, further and more recent observations were desirable, in which new methods of determination should be employed. M. Chacornac has recently followed up this inquiry, and has given us some new determinations of the apparent diameter of Sirius. The process adopted is as follows:—A "*lunette prismatique*," made by Secretan, is employed, suitably provided with superposed rotary prisms, producing the phenomenon of the gradual extinction of the extraordinary image of a star; the two images of Sirius are then brought into contact, so that there is no interval between them. This disposition effected, the second image is made to decrease in intensity until it arrives at the azimuth of apparition; the interval which separates them from centre to centre is then compared, taking for unity of measure the diameter of the extraordinary image. Operating in this manner, M. Chacornac finds that, for equality of brightness of the two images, the interval is originally from centre to centre equal to any one of the diameters of the image, whilst it is from five to six times the diameter of the extraordinary image when the images are most dissimilar in brightness. If the power be then doubled, and the operation is performed in the same way as for the lower power, without making any change in the prismatic arrangement, the ratio one-fifth becomes suddenly one-twelfth. The result of numerous measurements made with telescopes of very different power is, that it has always been possible to reduce the extraordinary image of Sirius, even in using the highest powers, to an imperceptible point. The apparent diameter of Sirius, as that of

each of the components of γ *Virginis*, is entirely factitious, and owing simply to the brightness of its light. This may be verified by repeating the determination with any one of the planets Mars, Uranus, Neptune, or with the satellites of Jupiter. It will be remarked that the apparent diameters of these objects do not decrease by diminishing the brightness when they subtend a sensible angle in the instrument employed with the prismatic glass.

The subject of solar physics has attracted a great deal of attention lately, and an important memoir on the nature of solar spots has lately been communicated to the Royal Society, by Warren De la Rue, F.R.S., Balfour Stewart, F.R.S., and Benjamin Loewy, Esq. The authors have attempted to answer the following questions :—

1. Is the umbra of a spot nearer the sun's centre than the penumbra? or, in other words, is it at a lower level?

2. Is the photosphere of our luminary to be viewed as composed of heavy, solid, or liquid matter, or is it of the nature of either gas or cloud?

3. Is a spot (including both umbra and penumbra) a phenomenon which takes place beneath the level of the sun's photosphere or above it.

In answering the first of these it was shown that if the umbra is appreciably at a lower level than the penumbra, we are entitled to look for an apparent encroachment of the umbra upon the penumbra on that side which is nearest the visual centre of the disc. Tables are given in the paper showing the relative disposition of the umbra and penumbra for each spot of the Kew pictures available for this purpose. From the first table it is shown that 86 per cent. of the cases are in favour of the hypothesis that the umbra is nearer the centre than the penumbra, whilst 14 per cent. are against it. From the second table, in which only spots of high latitude are considered, 80·9 per cent. are in favour of the hypothesis, whilst 19·1 per cent. are against it. The result of these tables shows, therefore, that the first question may be answered in the affirmative.

When discussing the second and third questions, it was observed that the great relative brightness of faculæ near the limb leads to the belief that these masses exist at a high elevation in the solar atmosphere, thereby escaping a great part of the absorptive influence which is particularly strong near the border; and this conclusion was confirmed by certain stereoscopic pictures produced by Mr. De la Rue, in which the faculæ appear greatly elevated. It was remarked that faculæ often retain the same appearance for several days, as if their matter were capable of remaining suspended for some time. From an examination of tables showing on which side of the sun-spots their accompanying faculæ are mostly found, it would appear as if the luminous matter, being thrown up into a region of greater absolute velocity of rotation, fell behind to the left, and we have thus reason to suppose that faculous matter which accompanies a spot is abstracted from that very portion of the sun's surface which contains the spot, and which has in this matter been robbed of its luminosity.

Again, there are a good many cases in which a spot breaks up, in

the following manner:—A bridge of luminous matter, of the same apparent luminosity as the surrounding photosphere, appears to cross over the umbra of the spot unaccompanied by any penumbra. There is good reason to think that this bridge is above the spot, for were the umbra an opaque cloud, and the penumbra a semi-opaque cloud, both being above the sun's photosphere, it is unlikely that the spot would break up in such a manner that the observer should not perceive some penumbra accompanying the luminous bridge. Finally, detached portions of luminous matter sometimes appear to move across a spot without producing any permanent alteration. From all this it was inferred that the luminous photosphere is not to be viewed as composed of heavy, solid, or liquid matter, but is rather of the nature either of a gas or cloud, and also that a spot is a phenomenon existing below the level of the sun's photosphere. The paper concluded with theoretical considerations more or less probable. Since the central or bottom part of a spot is much less luminous than the sun's photosphere, it may perhaps be concluded that the spot is of a lower temperature than the photosphere; and if it be supposed that all the sun's mass at this level is of a lower temperature than the photosphere, then we must conclude that the heat of our luminary is derived from without.

Dr. Reichenbach, of Vienna, has made a curious experiment. The existence of aërolites, meteors, &c., which frequently fall to the earth, has led some persons to the belief that the cosmical space is filled with a dust which sometimes becomes agglomerated so as to form large and small meteors, while at other times it reaches the surface of our earth in the form of an impalpable powder. Dr. Reichenbach has attempted to show the existence of such a powder, by collecting some of the dust from the top of a high mountain, which had never been touched by spade or pickaxe; upon analysis he found this dust to consist of almost identically the same elements of which meteoric stones are composed—nickel, cobalt, iron, and phosphorus. The doctor considers that we must look for the source of phosphorus in our soils to this mysterious invisible rain, which henceforth must be regarded as quite as necessary for vegetation as the water which falls from the clouds. This very pretty theory would stand more chance of being believed in by scientific men if there were no such thing as wind; but under the present conditions of atmospheric phenomena the existence of dust on exposed surfaces is more likely to be a terrestrial than a cosmical phenomenon.

Chronicles of the progress of astronomical science for the past quarter would not be complete were we to omit to mention that the French Academy of Sciences has awarded the Lalande Medal, the highest astronomical prize in the gift of the Academy, to Mr. Richard Carrington, of Redhill, the indefatigable observer of solar spots. This is the greater honour, inasmuch as Anglophobia is by no means rare amongst members of the French Academy.

Proceedings of the Royal Astronomical Society.

Some very careful observations on radiant points of shooting-stars were communicated to this society at the meeting on December 9th, by Mr. A. S. Herschel. This subject is one which this observer has made peculiarly his own, and the mass of facts which is being carefully collected and collated by such observers cannot fail to bear valuable fruit at no very distant time. The present paper, consisting as it does principally of diagrams and tabulary matter, defies condensation, but we may state that they appear to lead to the conclusion that the length in miles of the luminous excursions of meteors depends not so much upon the mass of a meteor as upon the depth of the inflaming atmospheric stratum through which it has to pass, and that this in general is the same for all meteors. The author likewise supposes that there are two meteoric orbits, neither of whose semi-axes major differ more than a fourth part from radii vectores of the earth. This supposition agrees with the evidence adduced elsewhere, by Professors Newton, Erman, and others, to show that the August and November rings of meteors very nearly coincide in their dimensions with the orbit of the earth. It adds fresh support to the conclusion that meteoric orbits approach in general very nearly to the circular form, but offers no explanation of their frequent retrograde motions and large obliquities to the ecliptic.

Professor Anwers has communicated the results of his researches relative to the orbit of Sirius, and has deduced, by a new computation, in most cases from the original sources, the following most probable values of the elements from 214 equations of condition; comprising, with trifling exceptions, the whole accessible material of observations, which prove to be trustworthy.

Passage through lower Apsis . . .	=1793·890 years.
Mean yearly motion	=7°28475
Time of revolution	=49·418 years.
Eccentricity	= 0·6010

In our Chronicles we have given some observations by M. Chacornac on the apparent diameter of Sirius. This note formed the subject of a few remarks by Mr. Pritchard, the Honorary Secretary of the Society, at their December meeting. He commenced by saying that although the meaning of the author's term, *lunette prismatique*, was somewhat doubtful, it seemed to refer to what in England would be called a double-image prismatic micrometer eyepiece. The image of a star formed by a lens with a circular aperture is well known to be a "spurious disc," surrounded by a few coloured rings, the cause being the interference of the waves of light which have passed through the object-glass. The intensity of the light in the spurious disc diminishes from the centre to the circumference, where it is a minimum; the light then varies again in intensity through a succession of maxima and minima thus furnishing the rings. Suppose, then, two images of the spurious disc to be formed by means of the "rotary prisms" referred to by M. Chacornac, and which leave the ordinary

image unaffected, but gradually extinguish the extraordinary image, it is plain that those parts of this image which are of the least intensity will be extinguished first. Thus as the prism rotates, the extraordinary image of the spurious disc will gradually contract by extinction into a mere point at the centre of the disc. It will be observed that all depends upon the variation of the intensity of the light from the centre to the circumference of the spurious disc, formed originally in the focus of the object-glass. Nothing of the sort takes place with a planet, inasmuch as the light does not sensibly vary in intensity from the centre to the margin.

At the January meeting of the Society, the Astronomer-Royal gave a comparison of the transit-instrument, in its ordinary or reversible form, with the transit-instrument in its non-reversible form, as adopted at Greenwich, the Cape of Good Hope, and other observatories. In the use of the reversible transit the line of collimation is found by observation of a fixed mark, or something equivalent to it, in reversed position of the pivots; in the use of the non-reversible transit the line of collimation is found by observation of two opposite collimators, which have been adjusted one upon the other. In the determination of errors of level and errors of azimuth there is no difference of method requiring notice at present. Both systems are theoretically quite accurate; no constant error attaching to either of them if the instrument is rigid, its pivots circular, and the bearings correct. The points, then, which require consideration at present are not the great and fundamental principles of construction, but the smaller points of flexure, irregularity of pivot form, and bad bearings. The Astronomer-Royal's communication was occupied principally with the consideration of the effects of flexure. It will be impossible to follow in abstract the mathematical considerations respecting flexure of the axis, flexure of the telescope tube, and the geometrical effect of such displacements on the path of the optical axis of the telescope. The conclusion arrived at being, that on every point the non-reversible transit-instrument is superior to the reversible or ordinary transit-instrument as commonly used.

One of the most important contributions to Physical Astronomy which has been laid before the Society for some time past, was communicated by Mr. Huggins at the same meeting. It had reference to the much debated question of a lunar atmosphere. The author considered that some important information on the subject of a lunar atmosphere might be furnished by observing the spectrum of a star a little before, and at the moment of, its occultation by the dark limb of the moon. It is well known that, from ordinary telescopic observation of the disappearance of a star under these circumstances, no indications of a lunar atmosphere have been detected. From the absence of such indications "we are," according to Sir John Herschel, "entitled to conclude the non-existence of any atmosphere at the moon's edge having one 1980th part of the density of the earth's atmosphere." When, however, the observation is made upon the *spectrum* of a star before, and at the moment of, its disappearance, several phenomena characteristic of the passage of the star's light through an atmosphere

might possibly present themselves to the observer. If a lunar atmosphere exist, which either by the substances of which it is composed, or by the vapours diffused through it, can exert a selective absorption upon the star's light, this absorption would be indicated to us by the appearance in the spectrum of new dark lines immediately before the star is occulted by the moon. Again, if finely-divided matter, aqueous or otherwise, of the nature of "fog," were present in the moon's atmosphere (a supposition to which telescopic observation is opposed), or even any considerable amount of invisible vapour, the red rays of the star's light would be enfeebled in a smaller degree than the rays of higher refrangibilities. In this case the blue end of the spectrum would appear to fade, leaving the red rays comparatively undiminished in brightness at the moment of the star's extinction.

If, however, there be about the moon an atmosphere free from "vapour," but of some density, then, because of the greater refraction which the more refrangible rays of the star's light would suffer in passing through it, the blue end of the spectrum would continue visible for a very small interval after the red rays had disappeared. Even if the moon's atmosphere were not of great extent, but sufficiently dense, the spectrum would probably not be extinguished at the same instant throughout its length, but a lagging of the violet and blue rays behind the red would be perceptible. The star examined was ε *Piscium*, at its occultation of January 4 last; the telescope had an aperture of 8 inches in diameter, and a focal length of 10 feet. In the spectrum apparatus two prisms were employed—one having a refracting angle of 35°, the other of 45°. The spectrum was viewed through a small achromatic telescope of 6·75 inches focal length, furnished with an eyepiece magnifying nine diameters. The telescope armed with this special apparatus was directed to ε *Piscium*, about five minutes before the almanac time of the occultation, which was 5h. 53m. The clock motion carrying the telescope was carefully adjusted, and by this means the image of the star was kept exactly upon the narrow slit of the spectrum apparatus. During a period of three minutes up to the disappearance of the star, the spectrum was observed steadily and without interruption. On the first point of interest, whether any dark lines additional to those belonging to the star appeared, Mr. Huggins is unable to speak decidedly. The state of our atmosphere was constantly varying, in consequence of which the stellar lines were seen with more distinctness at some moments than at others. A few seconds before the extinction of the star, some lines in the red, which had not been before noticed, were distinctly seen. These lines, however, might have belonged to the star, and have been brought out by a greater steadiness of our atmosphere at that moment. The mode of disappearance of the spectrum of ε *Piscium* can be described with more certainty. It was expected that the spectrum would disappear by a sudden failure of its light; but such was not the impression produced at the moment of extinction. The appearance suggested an opaque screen, equal in length to the spectrum passing before it with a rapid motion in the direction of its breadth. On this occasion the spectrum, as seen in the instrument, was very

narrow. The duration of the blotting out of the spectrum in this manner, though it was so small that it might perhaps be called instantaneous, yet occupied an interval of time which could be appreciated. This interval did not differ greatly from 2-10ths of a second. The disappearance of the spectrum was not observed to be preceded by any failure of the blue or of the red rays; but the spectrum appeared to remain unaltered in the relative intensity of its different parts up to the moment of extinction. The advance of darkness upon the spectrum, since it occurred precisely in the direction of its breadth, swallowed up the rays of different refrangibilities throughout the whole extent of the visible spectrum. The difficulties which attend the successful application of spectrum analysis to the heavenly bodies are so great, that much importance ought not to be given to a single observation of which the results are *negative.* A series of spectrum observations of the occultations of stars, especially if the list included some stars of greater brightness than ε *Piscium,* might possibly afford information of interest and value.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

(*Including Microscopic Botany.*)

Cell-Formation, or Cytogenesis, is still a subject of dispute among Vegetable Physiologists. Mohl advocated the formation of cells by the intrusion of a fold from the wall of the mother-cell, and this view was also supported by Naegeli. Schleiden laid great stress on the action of the nucleus, or cytoblast, in transforming the mucilaginous or protoplasmic matter into a gelatinous envelope, which ultimately became a membranous wall of a cell. Others supported a free-cell formation similar to what is seen in the formation of sporidia in the ascigerous fungi. Karsten has recently taken up the subject, and says, that in every case the formation of cells is free, and that the septa, or partitions, when in opposition with each other, arise from these confluent membranes, and not from any development of the wall of the mother-cell.

Schacht has recently examined the spermatozoids in ferns and their allies, in mosses, charas, algæ, and fungi. He says that these bodies are formed from the contents of the mother cell in the interior of the antheridium; that they consist of a soft cell-like body, with two or more cilia, and having no cell membrane, but simply a protoplasmic layer, enclosing fluid and granules. There are three typical forms of spermatozoids. 1. In Algæ the spermatozoid is a minute, elongated, rounded or pointed cell, with one, two, or more cilia, often of different lengths. 2. In Equisetums and Ferns the spermatozoid assumes the form of a flat band, which gradually widens from before backwards, and is rolled up like a watch-spring in the parent cell; when liberated it assumes a closely twisted spiral form. 3. In charas, mosses, and lichens the spermatozoid is sausage-shaped, and

is rolled up like that of the ferns. The motion of the spermatozoid consists chiefly of a rotation round its own axis, by which it wriggles as it were through the water bearing the cilia in front. The duration of the motion varies from a few minutes to many hours. Spermatozoids may be preserved for microscopical purposes in a solution of tannin (10 grains to the ounce), and in a solution of corrosive-sublimate (1 grain to the ounce) or in glycerine. The cilia are best seen after the spermatozoids have been slowly dried on the object-slide.

M. Corenwinder, in a communication to the Academy of Sciences, Paris, details experiments which lead him to the conclusion that neither the flowers nor the leaves of plants exhale carbonic oxide, or other combustible gases. He found that leaves exposed to the sun with a notable quantity of carbonic acid present, absorbed CO_2 rapidly but did not exhale CO.

The able Horticulturist Knight stated, that according to his observations a high temperature favoured the production of male flowers, while a lower temperature gave origin to female blossoms. He accounted in this way for the sterility of many plants grown in high temperatures. Naudin, however, is not disposed to adopt this view. He has made observations for ten years at least, on Cucurbitaceæ, and he finds that the male and female flowers appear to be independent of the state of the temperature. The character of the blossoms of these plants is according to him intimately connected with peculiarities of temperament which vary in different species and races, and even among individuals of the same race. The races of melons, squashes, and gourds, which have been long cultivated in Northern Europe, are comparatively more precocious and vigorous under heat for ripening their fruit than those of the same species recently introduced from tropical countries. Cucurbitaceæ attain their period of flowering and fruiting sooner under the hot and cloudless sun of the South of France than in Paris, where they grow luxuriantly, but do not flower well.

Mohl has examined the flowers of Oxalis, Viola, Specularia, and Impatiens, and has shown that self-fertilization must occur in these cases. In these plants the small and closed flowers are the fertile ones. In them the anthers while smaller in number have more active pollen. In Oxalis Acetosella, for instance, the larger anthers of the closed flowers contain only about 2 dozen pollen grains, and the smaller scarcely a dozen; while in the normal flowers the pollen grains are very numerous. The tubes from the pollen in the closed flowers send out their tubes to seek the stigmas, even at a considerable distance. From his researches, Mohl concludes that it is not a general law in hermaphrodite flowers, that nature should permit fecundation by the pollen of another flower in preference to its own pollen. In Fumariaceæ he remarks that the transport of pollen from one flower to the stigma of another is impossible on account of the mode in which the anther and stigma are enclosed by the petals.

Professor Lawson refers to a very remarkable boulder, in the Trent Valley, in Upper Canada, which was visited by him in company with

the Rev. W. Bleasdell, M.A., rector of Trenton, on the 6th June, 1862, and which he proposed to name the Bleasdell boulder. The following measurements of it are given :—

Length, 44 feet; breadth, 24 do.; height, west end, 19 do.; height, east end, 22 do.; greatest width of base, 21 do.; longitudinal circumference, 114 do.; lateral do., 77 do.

It lies due east and west, and is surrounded by a grove of iron-wood, overtopped by maple and beech. The following plants were found growing upon this huge stone: Rubus strigosus, Ribes cynosbati, R. rotundifolium, Silene Pennsylvanica, Fragaria vesca, Mitella diphylla, Solidago Canadensis Abies balsamea, A. alba, Lastrea marginalis, Polypodium vulgare, Adiantum pedatum, Hedwigia ciliata, Leptobryum pyriforme, Bryum roseum, Scyphophorus pyxidatus, Peltidea polydactyla.

The most characteristic boulder plants in Canada are Parmelia conspersa, P. cyanea, Schistidium apocarpum, Polypodium vulgare, Hedwigia ciliata, and Scyphophorus pyxidatus.

The occurrence of organic matter similar in composition to lignite and peat, is said to have been noticed by MM. Cloez and Wöhler, on a meteoric stone which was observed to fall at Orgueil, in France. Besides the usual inorganic matters an amorphous black matter like humus was seen, which on analysis was found to consist of carbon, hydrogen, and oxygen. The analysis of this meteorite would lead to the conclusion that organized matter existed in the region whence it came.

According to Unger, the Eocene fossil flora resembles much that of Australia at the present day; and the Tertiary flora has a marked resemblance to that of North America.

Dr. Greville continues his observations on Diatoms, and he has recently described the following new species from the South Pacific :— Campylodiscus humilis, Melosira nobilis, Auliscus Australiensis, Rhizosolenia striata, Cymbella Lindsayana, Navicula Robertsiana, N. sulcata, Stauroneis decora, S. obesa, Mastogloia Macdonaldii.

Mr. Charles Martins, of Montpellier, has shown that in high mountains there is an extraordinary heating of the soil, compared with the temperature of the air. He remarks that a solar ray falling on the summit of a mountain ought to be warmer than one falling on the plain, since the latter has lost most of its heat in traversing the dense atmosphere below. This is confirmed by observations made on the top of the Faulhorn, by Peltier and Bravais, in August, 1842; and by Bravais and Martins, in September and October, 1846. No less than 125 observations were made, and these showed the mean temperature of the soil during the day to be 53°·1 Fahr.; that of the air being 41°·7. Since that time Martins has made observations on the heating of the sun's rays of the same space of soil on an open plain at Bagnères de Bigorre, and the Pic de Midi. The two points are distant horizontally nine miles, and they are under the same meridian. The Pic isolated from the Pyrenees chain, rises to the height of 9,439 feet

above the level of the sea, while the plains of Bagnères are 1,808 feet above the sea-level. It was found that the mean of the temperature of the air in the shade at Bagnères was 97°·0; on the Pic 92°·8. The mean excess, therefore, of the temperature of the soil above that of the air at the two stations, is as 10 to 17; that is to say, about double on the mountain. The heating of the soil on high mountains is more remarkable when we consider the greater cooling by radiation at night as compared with the soil of the plains.

This temperature of the soil is intimately connected with the vegetation. Ramond, during fifteen years, made thirty-five ascents of the Pic du Midi, and gathered seventy-one flowering plants on the cone at the top of the mountain. Martins collected 131 flowering plants on the highest cone of the Faulhorn, the superfice being $3\frac{1}{2}$ acres, and the height of the mountain 8,803 feet above the level of the sea. According to Malmgren, Spitzbergen contains ninety-three flowering plants. Temperature may help to explain the number and variety of the species which grow on the summits of the Alps and Pyrenees as compared with the flora of Spitzbergen. In the former situation the roots of the plants are warmed by the soil to a much greater extent than in the latter. The heat of the sun's rays in Spitzbergen is absorbed to a great extent by the dense atmosphere above the soil. In Spitzbergen the ground remains frozen continually at the depth of little more than a foot, and the heat of the air and sun not acting powerfully on vegetation, the flora is reduced to a small number of plants. These live at a temperature only a few degrees above the freezing point.

It seems desirable that a similar series of experiments should be made on the plants found on the tops of the mountains of Scotland, as compared with those of the plains.

Dr. W. Lander Lindsay has given an account recently of the flora of Otago, New Zealand. Collections of plants were made by him in the settled districts between Dunedin, the capital of the province of Otago, and the Clutha river. These present a parallelogram of country about sixty miles long by twenty broad. It may be characterized as the lowlands or district of the plains, in contradistinction to the West coast region, which is that essentially of deep fiords with lofty mountain walls. It consists of a succession of plains and gentle uplands, with few hills of an elevation of more than 1,500 feet. Its flora may be said to represent the Eastern seaboard, the Eastern plains, and, generally, the settled districts of Otago. It differs materially from that of the Western Alps (which rise to 9,000 feet) of the central great Lake basins, and of the Western fiords, whose flora has, generally speaking, an alpine or sub-alpine character. Among the more characteristic herbaceous plants of the district are species of Olearia, Celmisia, Senecio, Cordyline, Panax, Drosera, Ligusticum, Thelymitra, Gaimerotia, Gahnia, Piltosporum, Plagianthus, Aristotelia, Nestera, Raoulia, Forstera, Dracophyllum, Gentiana, Veronica, Ourisia, Euphrasia, Muhlenbeckia, Pimelia, Fagus, Caladenia, Calerophus, Carpha, Uneinia, Hymenophyllum, Trichomanes, and Lomaria.

Fifty-eight natural orders, 147 genera, and 235 species, are included in his enumeration. He mentions five new species—Viscum Lindsayi, Celmisia Lindsayi, Poa Lindsayi, Aciphylla Colensoi, Crepis Novæ Zelandiæ, and exhibited drawings of them. There were also five species which had not been previously found in Otago; thirty were rare in Otago or New Zealand, or exhibited other interesting peculiarities of geographical distribution; twenty-five species were common to New Zealand and Britain; and twenty-seven were British plants naturalized. Hardy immigrant plants are gradually displacing the more delicate and rarer herbaceous natives of Otago and of New Zealand. In the majority of cases it is to the detriment of the colonist whose fields or pastures are destroyed by the luxuriant intruders, though in certain exceptional cases, for instance, in the pasture grasses and clovers, he is decidedly and largely benefited.

Among the British plants which are naturalized, or are becoming naturalized, near Otago, are the following:—Poa annua, Festuca bromoides, Lolium perenne (rye grass), Anthoxanthum odoratum, (sweet vernal grass), Holcus mollis, Phalaris canariensis (canary grass), Alopecurus agrestis (a kind of fox-tail grass), Phleum pratense (Timothy grass), Rumex acetosa, R. acetosella, R. crispus, R. obtusifolius (various species of Docks), Stellaria media (chickweed), Cerastium glomeratum, C. viscosum, Spergula arvensis, (spurrey), Brassica oleracea (cabbage), B. campestris (Swedish turnip), Nasturtium officinale (water-cress), Capsella Bursa-Pastoris, (shepherd's purse), Trifolium repens (white clover), T. pratense, (red clover), Vicia sativa (common tares), Plantago lanceolata and P. major (species of rib grass), Erodium cicutarium (stork's bill), Urtica urens (nettle).

Mr. M^cIvor reports in regard to the cultivation of Cinchona at Ootacammund, on the Neilgherries, as follows:—

1. Cinchona succirubra, Red bark, 102,344 plants.
2. C. Calisaya, Yellow bark, 2,137.
3. C. officinalis var. Condaminea, original Loxa bark, 4,494.
4. C. officinalis var. Bonplandiana (C. Chatmarquera), select crown bark, 232,980.
5. C. crespilla, 1,927.
6. C. lancifolia, Pitayo bark, 12.
7. C. nitida, 8,426.
8. C. sp., 2,769.
9. C. micrantha, 11,561,
10. C. Peruviana, 3,176.
11. C. Pahudiana, 425.

Mr. James M^cNab has made observations on some foreign Coniferous plants raised from seeds ripened in Britain. He remarks:—

"For some years past my attention has been directed to the Coniferæ raised from seeds ripened in Britain, and I have now to make some observations relative to the few species which have come under my notice, chiefly in the Edinburgh Botanic Garden. Beginning with Abies Douglasii, I have examined specimens taken from the trees originally in-

troduced by the late Mr. David Douglas, the botanical collector; some from seedlings introduced from North-west America during the last ten years; and some from plants (eighteen in number) raised from seed ripened in different districts of Scotland, and now growing in the Botanic Garden. The original trees in the Botanic Garden (introduced by Douglas), as well as those recently raised from seed direct from the American continent, are of a rich dark-green colour, having straight clean stems, while the majority of those raised from British ripened seeds have their leaves somewhat shortened, and of a yellowish green tint, with bare undulated stems, and branches more or less covered with resinous warts. Many of the plants raised from home-ripened seeds have a sickly look and a stinted appearance, notwithstanding that many of them had reached the age of from fourteen to fifteen years. The soil of the Botanic Garden is naturally of a light sandy description, and it may seem curious that the trees of the Douglas pine of foreign introduction should do so well, while the British seedlings should in so many instances dwindle away. In several counties in Scotland we are informed that fine trees of the Douglas pine are to be seen reared from home-saved seed. Soil, in connection with a more vigorous state of health of the seed-producing trees, may account for the present apparent luxuriance of the offspring. In several instances it has been found that specimen trees (not the original ones introduced by Douglas) are set down as British seedlings, and said to be as vigorous in growth as trees raised from imported seeds. Those who state this are probably not aware that, previous to British seedlings being produced, the Douglas pine was extensively propagated by layers and cuttings, and these layers and cuttings must now be noble trees. After British seedlings came to be produced freely, no more plants from cuttings were ever heard of. If a degeneracy exists, as I firmly believe it does, it would be well for cultivators to return to the original method of propagation by layers and cuttings, instead of trusting so much to home-saved seed. Several of those trees which produce cones freely are frequently stinted, and at a comparatively early age yield abundance of cones. It is universally acknowledged that in the case of the Scotch fir and larch, the healthiest seedlings are those produced by large vigorous trees; and that stinted trees, which often produce cones in great profusion, give rise to an unhealthy offspring. Such must also have been the case with some of the original Douglas pines, which had been placed in situations not altogether suitable for them, and at an early age became weak. The result is, that cones are freely produced; but the offspring, if any, cannot be relied upon. Plants, three or four years old, raised from home-saved seeds of the Douglas pine, as well as those of the Scotch fir and larch, look as healthy as those young plants of the same age raised from imported seeds. The constitutional weakness in the plants raised from British-saved seeds does not show at once, but at various periods from three to fifteen years after germination. Seeds of the Douglas pine are now being sent home freely, and ought to be eagerly sought after by cultivators. It does not always happen that foreign seeds will produce healthy vigorous trees. Some of those originally sent home by Douglas produced trees which do not assume the gigantic growth, and have not the fine green tints of vigorous trees. One variety, which was called the Abies Douglasii taxifolia, is of a yellowish green colour, with branches somewhat pendulous, having the stem and branches thickly covered with resinous warts. Although this tree is diminutive when compared with most of those introduced by Douglas, still it has an amount of vigour very different from seedlings raised from British-saved seed. We have in the Botanic Garden one of these pendulous trees, reared from a cutting,

standing side by side with the green upright form, proving in this instance that soil has not so much to do with the change as original constitutional weakness. I have also seen specimens taken from twelve seedling plants of Abies Menziesii, being part of the offspring of the noble tree now growing in the Keillour Muir Pinetum, Perthshire, the property of William Thomson, Esq., of Balgowan, and which is without exception one of the healthiest and finest trees of the kind in Europe. It was planted by the late Mr. Thomas Bishop, forester, Methven, about the year 1831. The tree grows in a deep, spongy peat soil, where it tillers freely, and cuttings stuck into the peat soon take root. The plants produced are very various, as seen by the specimens now exhibited. The seedlings were raised from seed presented to the Botanic Garden by Mr. Thomson during the year 1858, being from the first cones produced by the tree, and it may have happened that the male flowers were not perfected simultaneously with the female ones. In the neighbourhood various species of the Abies tribe exist in large quantities, particularly the Abies nigra, A. alba, A. rubra, and A. excelsa. As some of them stand within 50 yards of the Abies Menziesii, judging from the diversity of seedlings, I am inclined to think that some of the young female cones must have been fertilized with the pollen of some of the above-mentioned trees, particularly with that of the Abies nigra; as it is a remarkable fact that the nearer the seedlings approach to the Abies nigra, the more healthy and compact they become. Specimens of Abies Menziesii raised from home-saved seed, just received from Balgowan, exhibit much the same appearance as those raised in the Botanic Garden. Although healthy, none of them possess the vigour of a specimen taken from a young tree struck from a cutting eight years ago. The seedlings of Picea nobilis, raised from British-saved seed, vary very much, but none of them possess the vigour of foliage as exhibited by the large tree now growing in the Botanic Garden, raised from seed originally sent home by Mr. Douglas, or even the plants reared from layers and cuttings taken from the original trees. The British seedlings look well till they get about one foot high, at which size they begin to assume a yellowish tint, and finally decay. Many of the seedlings are now dead, the largest having attained the height of three feet. These circumstances prove that early decay is not altogether depending on soil, as layers and cuttings from the originally imported seedlings are as healthy as the original trees. Precisely the same remarks apply to the British seedlings of the Pinus monticola—all assuming a yellowish tint after they reach four or five years of age. These remarks may not be applicable to British seedlings planted in a peaty soil where the monticola seems to grow best. Such, however, is the case with the plants raised from home-ripened seeds now growing in the Botanic Garden, but not with those from imported seed. It may be said that layers and cuttings of coniferous trees, particularly of the Picea and Abies tribes, are not so very easily produced. With layers I would recommend the twisting of a small piece of very fine copper wire round the branch, sufficiently tight to compress the bark without bruising it, previous to being pegged into the soil. When so treated, the majority of them will be found rooted twelve or eighteen months after being laid, according to the nature of the wood. Young points not more than two years old should be used. Cuttings take a much longer time. They have been successfully rooted under handglasses at the base of a north-exposed wall, where no sun can reach them; also in pots well drained and filled with sand and placed in a cold frame."

At a meeting of the Microscopical Society of Edinburgh, Dr. Dickson lately gave the results of his observations upon the development of

the flower in *Mentzelia aurea.* He had been able to verify almost all the details given by Payer in his *Organogénie* as to the same genus. Dr. Dickson called attention to an important point to which Payer has not adverted—*viz.* the time at which the three carpellary processes make their appearance. He finds that the carpels are developed at a very early period. They are distinctly to be seen when only the stamens of the first three degrees have appeared, and are probably developed about the same time as the stamens of the second degree. The carpels are thus developed long before the great mass of the very numerous stamens.

This fact Dr. Dickson considers quite irreconcilable with Payer's idea that the andrœcium in *Mentzelia* and its allies consists of a plurality of whorls, in which respect Payer holds them to differ essentially from *Loasa* and its allies where the andrœcium consists of a single whorl of five compound stamens.

The fact that the greater number of the stamens do not make their appearance until after the carpels, taken in connection with the evident grouping of the stamens of the first three or four degrees, leaves, in Dr. Dickson's opinion, no room to doubt that the andrœcium of *Mentzelia* consists of a single whorl of five confluent staminal groups or compound stamens. The most important difference between these groups and those in *Loasa* consists in their being centripetally developed, as regards the axis, in the former, a mode of development analogous to that of the compound stamens in the Myrtaceæ, while in the latter the development is centrifugal, analogous to that in *Hypericum*, &c. In *Mentzelia*, as in *Loasa*, the staminal groups are superposed to the sepals. Although the difference in the evolution of the staminal lobes in the two cases is undoubtedly an important one, Dr. Dickson thinks that botanists would hardly be justified in separating the Mentzeliæ and Loaseæ into distinct orders, as has been done by Payer in his *Leçons sur les familles naturelles.* The analogy between the two groups in all respects excepting the staminal evolution, is so remarkably close, that it cannot but be satisfactory to be able to retain the old order Loasaceæ intact.

In speaking of climbing plants at a late meeting of the Linnean Society, Mr. Darwin says:—"The perfection of the organization of plants is forced on our minds by the study of the many kinds that climb. Let us look at one of the more highly-organized tendril-bearing climbers. It first places its tendrils ready for action, as a polyp places its tentacles. If the tendril be displaced, it is acted on by the force of gravity and rights itself. It is acted on by light, and bends towards or from it, or disregards it, whichever may be most advantageous. During several days, the tendril or internodes, or both, spontaneously revolve with a steady motion. The tendril strikes some object, and quickly curls round and firmly grasps it. In the course of some hours, it contracts itself into a spire, dragging up the stem, and forming an excellent spring. All movements now cease. By growth, the tissues soon become wonderfully strong and durable. The tendril has now done its work, and done it in an admirable manner."

Dr. Julius Haast, Provincial Geologist of Canterbury, New Zealand, gives, in his report of the Geological Survey of the Province, an account of the plants found on its mountain ranges in the interior. His collection includes specimens from about 1,000 feet above the level of the sea to the line of perpetual snow. He enumerates 450 flowering plants, and 42 Ferns, Lycopods, and Marsileads.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Few persons have devoted themselves to the study of a favourite subject with so much constancy as Schönbein. Many years have now passed since that industrious experimenter first discovered ozone and pronounced it an allotropic modification of oxygen. Pursuing the same subject, he afterwards arrived at the conclusion that when ordinary oxygen, such as exists in the atmosphere, enters into combination with oxidizable matters, organic or inorganic, in the presence of moisture, the molecule of neutral oxygen becomes split up into two oppositely active atoms, or, as he expresses it, undergoes "chemical polarization." One of these atoms, he believes, unites with the metal or other oxidizable matter, while the other combines with the water to form peroxide of hydrogen. The fact of the production of peroxide of hydrogen, as well as a metallic oxide, during the slow oxidization of metals, Schönbein long since placed beyond dispute, but his theory of chemical polarization required an experimental demonstration of the fact that exactly the same amount of oxygen combined with the water as combined with the metal.

This demonstration he seems now to have accomplished. In some recent "contributions to a knowledge of oxygen," * he gives a method of determining, with all necessary accuracy, the proportion of oxygen united in each case. There are some difficulties in the way of obtaining an exactly equivalent amount of peroxide of hydrogen, mainly depending upon the unstable nature of that remarkable body. The actual results, however, come so near, that no doubt is left of the truth of Schönbein's theory.

We leave the rather lengthy details of the experiments to those specially interested in the subject, who will find them in the place indicated below; but we may give a short outline of the author's method. He shakes an amalgam of mercury and lead, containing five per cent. of the latter metal, with some very dilute sulphuric acid of known strength, in a capacious flask partially filled with either atmospheric air or pure oxygen. After but a few moments' agitation, a perceptible amount of sulphate of lead is formed, and peroxide of hydrogen is found in the acidulated water. By taking a measured quantity of this water, and determining the amount of uncombined acid, the author arrives at the proportion of acid which has combined with the lead, and from the amount of sulphate of lead calculates the oxygen which has united to form oxide of lead. The peroxide of

* 'Journal für prakt. Chemie.' Bd. 93, pp. 24–60.

hydrogen he estimates in another portion of the water, by means of a standard solution of permanganate of potash.

The foregoing will show the general method pursued in this interesting inquiry, and we need only remark further, that in none of the experiments was a proportion of peroxide of hydrogen found exactly equivalent to the oxide of lead. But this is clearly shown to be a consequence of the rapid decomposition of the peroxide.

Schönbein has also studied the behaviour of oxygen to other metals, bismuth, nickel, cobalt, thallium, &c., and with these also has arrived at facts which support his theory of chemical polarization. In connection with these experiments he gives a new and most delicate test for peroxide of hydrogen. To water supposed to contain that body he adds one or two drops of a salt solution of one of the above-named metals, and then a few drops of potash just sufficient to precipitate the hydrated oxide of the metal. He now adds a very small quantity of solution of starch with iodide of potassium; and lastly, a drop or two of acetic or dilute sulphuric acid. If, now, the merest trace of the peroxide is present, the mixture is instantly coloured blue.

Important as Schönbein's investigations are to general chemistry, they have a far greater importance when considered in relation to physiological chemistry. The author considers that oxygen undergoes chemical polarization in the body when respired, and would thus account for the active changes which take place in the tissues. He has not yet succeeded in detecting the presence of peroxide of hydrogen in the blood, but he has shown that blood corpuscles instantly decompose the compound. He has, however, found it in urine, and explains by its presence the rapid oxidization of that fluid. Altogether these researches of Schönbein must be regarded as some of the most important on which chemists are engaged.

Since the above was printed we have seen it announced that Schönbein has succeeded in isolating both ozone and antozone, the two bodies of which ordinary oxygen is composed. Antozone has a density less than that of hydrogen, and therefore is the lightest body known. It liquifies at a pressure of 150 atmospheres. The two gases combine with explosion when exposed to the dark rays of the spectrum, and ordinary oxygen is reconstituted. This decomposition of a gaseous element must be regarded as one of the greatest chemical discoveries ever made, and we impatiently wait for a confirmation of the statement.

Sulphur is a body credited with several allotropic modifications, which, however, seem rather to affect its physical condition than its chemical properties, but the latter are to some extent changed. Thus Dietzenbacher has recently shown that by fusing only $\frac{1}{400}$th part of iodine with sulphur, the mass, after cooling, remains soft and plastic, and moreover has become insoluble in sulphide of carbon. More recently the same author, in conjunction with M. Moutier, has discovered* that many organic substances also possess the same power of modifying the condition of sulphur. Naphthaline, camphor, creosote, oil of turpentine, and even carbon alone, render it soft and plastic, and partially insoluble in sulphide of carbon. Wax and oil also render it soft, but

* 'Comptes Rendus,' t. lx. p. 353.

the solubility is not affected by these agents. The authors seem to regard this power of carbon, and bodies rich in carbon, to alter the physical and chemical properties of sulphur, as to some extent comparable to the effect of carbon in the conversion of iron into steel.

One practical result of these investigations has been to show the possibility of making large plates of sulphur for electrical machines which will be unaffected by moisture and atmospheric influences.

The mention of bisulphide of carbon recalls to our mind that Mr. Lewis Thompson has lately made public* a simple method of removing this pernicious ingredient from gas. He takes advantage of the fact that the vapour of bisulphide of carbon, and the vapour of water cannot exist together at a high temperature without undergoing a double decomposition resulting in the formation of sulphuretted hydrogen and carbonic acid. He therefore proposes to mix the gas as soon as it leaves the hydraulic main with a certain amount of steam, and to send the mixture through tubes heated to redness, in which the decomposition will take place. The resulting compounds, as probably all our readers know, are common ingredients in raw gas, and will be removed by the ordinary methods of purification. How this process will answer on the scale of manufacture common in our large gas-works we cannot say; but seeing the objectionable effects which are produced by the sulphurous acid generated in the combustion of sulphide of carbon, and probably other sulphuretted compounds in gas, the process deserves a serious trial.

Deville continues his valuable researches on the phenomena of *dissociation*, and has now invented an ingenious apparatus by which the partial decomposition of bodies below the temperature of complete decomposition can be satisfactorily demonstrated. This apparatus† consists of a porcelain tube, which carries within it a copper tube of smaller diameter. The tube being disposed in a convenient furnace, the gas to be experimented upon is passed through the porcelain tube, and at the same time a current of cold water is sent through the copper tube. The diminished temperature in the neighbourhood of the inner tube prevents the recombination of the separated components, and by certain arrangements the facts of the dissociation are clearly shown. Thus, in the case of carbonic oxide free carbon is deposited on the surface of the inner tube, while carbonic acid is found in the escaping gas. Sulphurous acid is dissociated into sulphur and oxygen, which latter unites with the excess of sulphurous acid to form sulphuric acid. In order to show this, Deville coats the surface of the copper tube with silver, which becomes blackened by the sulphur, while the sulphuric acid may be washed from the surface, and detected by means of baryta. The dissociation of hydrochloric acid is shown as clearly by amalgamating the silvered surface of the tube. By this means chlorine is fixed as chloride of silver and mercury, while free hydrogen is found in the gas which escapes.

The author does not appear to have experimented in the above way with carbonic acid and ammonia; but he states the results

* 'Newton's Journal of Arts,' Feb. 1865.
† 'Comptes Rendus,' Nov. 28, 1864.

arrived at with the induction spark. Carbonic acid is completely decomposed by the induction spark when a piece of phosphorus is placed on the surface of the mercury in the eudiometer tube to absorb the oxygen set free. After passing the sparks for twenty-four hours, only an equal volume of carbonic oxide was left.

Deville also points out that although a volume of ammonia is doubled by the action of the sparks, the decomposition is never complete. Notwithstanding that no absorption is shown when water is introduced into the eudiometer, a few bubbles of hydrocloric acid passed in, determine the deposition of chloride of ammonium, and the mercury instantly rises.

Messrs. Buckton and Odling have made an important discovery in some organo-compounds of aluminium.* They have formed aluminium ethide and methide. Apart from the importance of these compounds in determining the atomic weight of aluminium, they possess great interest in themselves. They are both colourless, mobile liquids, which take fire spontaneously in the air, burning with a smoky flame, which, along with the carbon, produces abundant flocculi of alumina. In water the ethide decomposes with explosive violence. The determinations of the vapour densities of these bodies have led the authors to the adoption of the formulæ $Al\ Et_3$ and $Al\ Me_3$, which agrees with the high atomic weight required by the specific heat of aluminium. It must be added that the vapour density of aluminium methide, like that of aluminic chloride, appears to be anomalous.

Professor Williamson, in a communication to the Royal Society,† has since shown strong reasons for still adhering to the low atomic weight of aluminium.

In connection with organic chemistry, we may mention that Dr. Hofmann has contributed‡ further researches on the colouring-matters derived from coal-tar, which we must now cease to speak of as aniline colours since the author and Mr. Nicholson have shown that toluidine is an essential constituent. These researches, while conclusive against the views of M. Schiff, still leave the exact constitution of the colours a matter of conjecture.

In advanced organic chemistry we need hardly say that incessant and rapid progress continues to be made, the discovery of new bodies almost exceeding the ingenuity of the discoverers to find names for them. From these discoveries we gain daily a clearer insight into the constitution of chemical compounds; but at present it is impossible to convey to general readers an idea of the facts revealed.

Plants containing theine have been so universally adopted as articles of diet, that man would seem to have been guided to their use by a sort of instinct. Physiologists may dispute about the use and the evils or benefits which result from it, but it is a fact that everywhere man, civilized and uncivilized, seems to exhibit a craving for substances that contain it. The medicinal effects of pure theine have as yet been but imperfectly ascertained, and we may regard it as fortunate that a new

* 'Transactions of Royal Society,' v. xiv. p. 19.
† 'Transactions of Royal Society,' xiv. p. 74.
‡ 'Transactions of Royal Society,' v. xiii. p. 485.

and prolific source of the body has been discovered in a substance which seems to be hardly available as an article of diet. The negroes of Soudan and tropical West Africa hold in high esteem the seeds of *cola acuminata*, known as the Guru-Nut of Soudan, or Kola-Nut of West Africa. In these Drs. J. Daniell and Attfield have discovered that theine exists in almost as large a proportion as in tea. As, however, the taste of the nuts seems to be unpleasant to European palates, and no mode of preparation is yet known to make it agreeable, they do not seem to be suited for an article of diet. We content ourselves, therefore, with pointing them out as a new source of theine.

Proceedings of the Chemical Society.

Since the publication of our last notice, the Chemical Society has been engaged for the greater part of two evenings in discussing Chemical Nomenclature and Notation. The subject was introduced by Professor Williamson, who, being engaged on a new elementary work, is ambitious of introducing a more precise and satisfactory system than that which is at present current. It would be impossible to convey to our readers, in the short space we can devote to the subject, an adequate idea of the Professor's views—hardly elaborated with sufficient distinctness, in the communication read—and we therefore wait the publication of the work in which we shall find the system he proposes applied. In the meantime, it was eminently unsatisfactory to find from the discussion, in which all our leading teachers joined, that chemists are by no means agreed upon the fundamental principles which must guide us in the adoption of a perfect system of nomenclature. Sir B. Brodie, indeed, seems to be of opinion that chemistry has reached a stage in which it will be found convenient to abolish the use of names altogether, and to describe things by formulæ alone.

Some laboratory memoranda communicated by Mr. R. Warington, jun., contained practical information of much interest. The colour-changes produced by the reaction of ferricyanide of potassium on ferric salts are variously described in Manuals of Chemistry, some asserting that dark or reddish brown fluid is produced, while others state that the liquid is greenish or dark-green. The author showed that these different appearances are produced by varying the proportions of the reacting compounds. Thus, the dark-brown liquid is produced when the ferricyanide is in excess of the ferric salt; and when the proportions are reversed the green colour results. With regard to the question of a precipitate, it was shown that when sufficiently acid the liquid remained clear; but with basic ferric salts a pale-brown precipitate is thrown down by ferricyanide of potassium.

Another memorandum on the solubility of magnesia in alkaline salts, showed that magnesia is to some extent soluble in salts of potassium and sodium, as well as of ammonium, though to a far smaller degree.

The most interesting meeting of the season, has been on the occasion of a discourse by Dr. Hofmann, on Lecture Experiments. There are several unquestioned facts in chemistry which must in general be taken for granted, since their experimental demonstration

before an audience is attended with many difficulties. One of these is the fact, that hydrochloric acid is composed of equal volumes of hydrogen and chlorine. By the electrolysis of hydrochloric acid as usually effected, equal volumes are never obtained; and the synthesis of equal volumes by the electric spark is never complete. Dr. Hofmann, however, showed methods of accomplishing both the analysis and synthesis of hydrochloric acid, and satisfactorily demonstrated that two volumes of the constituents produce exactly two volumes of the compound.

The lecturer next performed an experiment designed to demonstrate the fact, that two volumes of hydrogen and one volume of oxygen, combine to produce two volumes of aqueous vapour. To show this, the tube containing the mixed gases is enclosed in another tube, through which a current of the vapour of boiling amylic alcohol is maintained. The temperature of the mixed gases is thus kept at about 130° C. On passing the electric spark explosion ensues as usual, but the water formed is necessarily retained in a state of vapour, and on opening the tube under mercury it is seen that the compound resulting from the explosion only occupies two-thirds of the bulk of its constituents.*

The constitution of ammonia by volume was next illustrated, as usual, by means of the induction spark. It was shown that by the passage of the sparks the gas was resolved into constituents which occupy twice the volume of the compound. But the most striking experiment exhibited was that which showed the exact bulk of the nitrogen present in ammonia. A long tube marked into three divisions, by India-rubber rings, was filled with chlorine, and to the open end was adapted a small globe containing strong ammonia. On allowing a few drops of the liquid to enter the tube, a flash of light was observed; more ammonia was then admitted, and the tube was warmed to complete the decomposition. A little dilute sulphuric acid was then introduced to remove excess of ammonia; and now the tube being opened in communication with the same liquid, it became filled to the extent of two-thirds, leaving one-third full of pure nitrogen. Since it had been shown in a previous experiment that chlorine always unites with a volume of hydrogen equal to its own, the last experiment proved that in ammonia three volumes of hydrogen are united with one volume of nitrogen.

The only typical compound remaining, the volume composition of which requires demonstration, is marsh gas; at present, however, we have no means of experimentally illustrating the composition of this body.

Another paper, of much interest, was by Mr. Broughton, describing a new reaction for the production of anhydrides and ethers. The ready decomposition of sulphide of carbon, at a high temperature by metallic oxides, and even by water, with, in the latter case, the production of carbonic anhydride, led the author to think that by the action of sulphide of carbon on organic metallic salts, a sulphide of the

* It is right to say that this beautiful experiment, which was not completely successful before the Chemical Society, Dr. Hofmann repeated with most perfect success in one of his recent lectures at the Royal Institution.

metal would be formed and the anhydride set free. The supposition was confirmed by experiment. Acetate of lead heated with the sulphide yielded acetic anhydride. The principle of the reaction is also applicable to the formation of compound ethers, since it allows the anhydride in a nascent state to react on an alcohol. Mr. Broughton prepared acetate of phenyl, by making bisulphide of carbon react on the corresponding lead salt in the presence of phenylic alcohol. It would seem possible also to effect the isolation of anhydrides of electro-positive radicals, or ethers, by taking advantage of the above-mentioned general reaction, and the author has commenced experiments with the view of eliminating phenylic ether from phenate of lead. For a more precise account of these interesting experiments, we must refer the reader to the 'Journal of the Chemical Society,' for January.

Another paper of more technical interest was by Mr. J. Spiller, on the Oxidation of India-rubber. The article of commerce known as Patent Waterproof Felt, is found to undergo in the course of time a remarkable change. It loses its strength, close texture, and waterproof qualities, and becomes hard and inelastic. This led the author to make a chemical examination of the new as well as the altered fabric. From the former benzol extracted perfectly pure and elastic India-rubber; but the solution from the latter yielded only a resinous, brittle, brownish-yellow substance, resembling shell-lac. The properties of this resin differ considerably from those of India-rubber. It is freely soluble in warm alcohol, in wood spirit, in chloroform, and in benzol; but is not appreciably soluble in ether, in bisulphide of carbon, or in oil of turpentine. Alkalies dissolve it with ease, and it is precipitated from such solutions on the addition of an acid. Like India-rubber it is bleached when immersed in strong ammonia. It fuses at a low temperature, and when strongly heated gives off an empyreumatic oil and water. When dry it is extremely brittle and highly electric. It can only be regarded as oxidation product of India-rubber formed by the absorption of atmospheric oxygen in much the same manner as resins are formed from essential oils and other hydrocarbons; and it was further remarked, that gutta percha and caoutchouc seem both to furnish the same product by the absorption of oxygen. In the course of a short discussion on the subject, Mr. De la Rue observed that the material which had undergone the change described, contained no sulphur; he had had, however, in his possession for eighteen years, samples of a similar material, containing sulphur, which had undergone no change.

An account of some Brine Springs in Nova Scotia, by Professor How, introduced a short discussion on the mode of stating the results of a water analysis, in the course of which Professor Williamson observed that it was not always correct to follow the directions of Fresenius, and combine the strongest acids with the strongest bases. A truer method would probably be to place every acid in part combination with every base, but such an arrangement would be practically impossible.

Several papers of much interest to advanced chemists have, as

usual, been contributed to the Society's Proceedings, but of these we give only the titles. "On the Action of Ammonia on Sulpho-chloride of Phosphorus," by Dr. J. H. Gladstone and Mr. Holmes; "On the Artificial Formation of Pyridine," by Mr. Perkin; "A Note on the Action of Chloropicrin and Chloroform on Acetate of Potash," by Mr. H. Bassett.

V. ENTOMOLOGY.

(*The Entomological Society of London.*)

It is usually our custom to include an account of the progress made in any section of Natural History in one of the Chronicles devoted to that branch of Science; but a special reference to the state of Entomological Science is rendered necessary by the Report recently issued by the parent Society in London.

Entomology is not thriving. It has lost some of its most ardent votaries, and there are no doubt many of our readers for whom it will suffice to mention the names of two of its disciples who have passed away, William Kirby and William Spence, to awaken in them a fresh enthusiasm for their favourite pursuit, and to remind them how needful it is that the labours of those veterans should not be permitted to eclipse the present and future contributions to Entomology.

We have before us at this time a note, written in a clear and firm hand, received from Mr. Spence in December, 1858, concluding with the announcement that "the whole of the 7th thousand of our book" (Kirby and Spence's Entomology) "are sold, and five hundred of the 8th thousand." The same note contains references to "what has been doing in Entomology this year," and gives us a vivid picture of the brave old man, who, to the close of his life, was so devoted and liberal a supporter of his science.

Without wishing to charge the living generation of Entomologists with apathy, we cannot help feeling that when those two stars waned, a shade passed over the science, which the united labours of Stainton, Newman, Westwood, Bates, Blackwall, Dallas, Lubbock, and others equally famed, have not succeeded in dispelling.

Mr. Pascoe, the President of the Entomological Society, has placed before the votaries and students of his branch of Natural History an address* containing a concise account of its present position and future prospects, and it affords us great satisfaction to give it a wider publicity, for it is well worthy of the attention of all scientific men, and merits a hearty response from all the lovers of Natural History. Mr. Pascoe tells the members of the Society that he cannot congratulate them on an increase of their funds, and that although their library is increasing in value, and the Transactions (which are sold at half-price to town members, and delivered *free* to country members) have never been so important as now, their sale is

* The Address of the President of the Entomological Society of London, 1865.

very limited; and on turning to the account of the treasurer, we are sorry to find that the outlay for this object considerably exceeds the income from the same source, and also that the amount of guinea subscriptions for the year 1864 is only 101*l.* 17*s.*, there being but ninety-seven members.

This is not as it should be. We know many unimportant provincial societies numbering half-a-dozen times as many members, and with revenues in proportion. Surely the Entomologists (and indeed the Zoologists) of Great Britain will not allow this report of the state of the parent Society to be repeated. At the conclusion of this brief notice, we append a circular that has just been issued by the Society; but let not our readers go away with the impression that the Society can do nothing besides making appeals. The President's address touches in a cursory, but interesting manner upon the progress of Entomology at home and abroad.

He refers to various articles which have appeared in Magazines and Reviews, mentioning, among others, that of the Rev. T. A. Marshall, "On the Sub-family Corynodinæ," in the 'Proceedings of the Linnean Society;' of Mr. Rye, "On the Staphylinidæ," in the 'Entomologists' Monthly Magazine;' of Mr. Trimen, "On the Insect Fauna of Madagascar," in the October Number of this Journal; and Mr. Murray's "Monograph of the Nitidulidæ," in the 'Linnean Transactions.'

He informs us that the trustees of the British Museum have issued "Mr. Wollaston's Catalogue of the Coleopterous Insects of the Canaries," filling six hundred pages, and accurately describing 930 species.

Mr. Blackwall's "History of the Spiders of Great Britain and Ireland" (reviewed in the October Number of this Journal) is also mentioned with commendation; and the observations of Mr. Blackwall regarding the means by which insects are enabled to adhere to smooth surfaces, are summarized. This subject is by no means settled by Mr. Blackwall, for there are difficulties in the way of the acceptance of his "viscid fluid" theory, just as great as the "vacuum" doctrine of West and others.

The researches of foreign investigators are not forgotten, and those of Baudelot on the influence of the nervous system on respiration of insects; of Claparède on the "pericardiac lacunæ" of *Lycosa*; of Mr. Walsh, of Philadelphia, on dimorphism in *Cynips*, are all briefly referred to. Our limited space prevents us from touching upon other interesting features in the address; but we cannot help noticing the curt judgment passed upon the lucubrations of the 'Times Bee-master,' with which the columns of the leading Journal were so long inundated. Uninitiated readers who waded through these will be astonished to hear them characterized as "rather a work of the imagination than a statement of facts."

The President complains of a want of simple catalogues or "lists of the published species of families, sub-families, and orders (of insects) with reference to the places where they are described, or where anything valuable concerning them is to be found," and he

suggests that the Linnean or Zoological Societies should undertake the work of publication.

We trust, however, that the following appeal just issued will be heartily responded to; and that so far as the Annulose sub-kingdom is concerned, the Entomological Society may itself be enabled to carry out the suggestions of its President.

"*The Entomological Society of London.*

"The Entomological Society of London was founded in 1833, for the purposes of forming a centre of union for British Entomologists, of amassing a Library of Entomological Books, and of publishing in its 'Transactions' papers on Entomological subjects.

"The Society is now producing the 12th volume of its Transactions. During the last year it published 560 pp. of letter-press, illustrated by 22 Plates. The inadequacy of its funds to defray the expense of printing and illustrating all the valuable contributions to Science which are offered to it, and which, from the unremunerative nature of such publications, may probably not otherwise issue from the press, induces the Council to make an appeal to the patrons of Science in general to join the Society, and thereby enable it to enlarge its present sphere of usefulness.

"The Council is extremely desirous of increasing the knowledge of the Entomology of our own country, and on that account asks more particularly for the assistance of the many Entomologists who are scattered over the United Kingdom; especially also is it anxious to devote attention to Economic Entomology, and requests therefore the support of agriculturists and horticulturists, and of all who are interested in the habits and economy of insects, and the best modes of cultivating the useful and of destroying the noxious species.

"The Council has recently offered two Prizes of the value of Five Guineas each, to be awarded at the end of the present year to the Authors of Essays or Memoirs of sufficient merit on subjects belonging to the economic department of the Science.

"The Society consists of Members (who pay an Admission Fee of Two Guineas and an Annual Contribution of One Guineas) and Subscribers (who pay the same Annual Contribution, but are exempt from any Admission Fee). Both are entitled to attend and introduce visitors at the Monthly Meetings of the Society, to use the Society's Library, and, if resident more than 15 miles from London, to receive gratuitously the 'Transactions' as they appear, thus actually obtaining an equivalent for the amount of the Subscription. Members or Subscribers residing within the above limits can purchase the Transactions at half-price.

"Papers of high scientific interest are awaiting publication, the furtherance of Science is the sole object of this appeal; and the Council trusts that it will result in a considerable increase of the Contributing Members of the Society."

The address appended to this appeal, which is signed by the President, is 12, Bedford Row, London, W.C.

VI. GEOGRAPHY.

(*Proceedings of the Royal Geographical Society.*)

A FRIEND once remarked to us on the subject of African missions, that it was necessary to cast a great deal of rough-cut but good stone into the sea before it was possible to build a mole to stand above the surrounding waters, or to raise a breakwater against the ocean waves. It is much the same with African explorations. Many a sterling, honest, scientific traveller is struck down before his work is completed, before he raises any monument to himself which stands out above the flood of ignorance and barbarism that overwhelm that land. Such an one was Dr. Baikie. He was the son of a captain in the navy, born at Kirkwall, and educated in the Grammar-school of that place, whence he proceeded to the University of Edinburgh, where he graduated in medicine. He joined an African exploring party in a medical capacity. For the last six years he has travelled independently, and has acquired much scientific information, which will probably be given to the public at some future time. He was returning to this country, and had arrived in Sierra Leone, in order to take the mail, when he was seized with dysentery and fever, which carried him off in two days. It seems almost to be doubted if the expenditure of valuable lives like this is repaid by the scanty effects of African discovery.

Of another party, that of the Dutch ladies who tried to ascend the western branch of the Nile — Madame Tinne herself, two of her maids, Dr. Steudner, and Herr Schubert, and, after an interval, Madame de Capellan — have all perished in the course of a third journey into the interior. Of their companions, however, Fraulein Alexine Tinne, Baron von Heughlin, Herr Mumzinger, and Moritz von Buermann still remain.

From Africa there is but little new. The old is still being brought over by those who are competent to appreciate the earnestness of travellers, the difficulty of travelling, and the impossibility of absolutely avoiding mistakes. Charity is a virtue not as yet cultivated by the Africans, whether of white or black skins.

M. Rolfs Gérard is returning to Europe, after a journey into the interior of Morocco, south of the Atlas range. He is anxious to set on foot a new expedition over somewhat similar ground. Dr. Livingstone proposes to visit that part of the east of Africa which lies between his own most northern point on Lake Nyassa and Burton and Spekes's' southernmost part of Lake Tanganyika. He is to be assisted with 500*l.* from the Geographical Society, as much from the Foreign Office, and a private friend has contributed 1,000*l.*, to which may be added the Doctor's salary of 500*l.* a-year, as consul to the native races of Eastern Africa.

Farther south, the Government talk of annexing the district called British Kaffraria to the Cape Colony. The boundary of the province will henceforth be the river Kei, whilst the land which was previously occupied by the Cape mounted police, between the Kei and the Bashee, will in future be left to certain Kafir chiefs, who will be

under an amount of restraint and rule from Mr. Warner, the superintendent of the Tambookies in Cape Colony, who will for the future live beyond the frontiers for the purpose of regulating these barbarous chiefs, most of whom receive some salary from our Government, and are therefore partially amenable to our rule.

An account of "Madagascar and its People" has been written by Mr. Lyons M'Leod, formerly consul on the opposite coast of Mozambique. Naturally from his position the writer has been able to collect the best materials for such a work, which includes a history of the island, from its earliest discovery down to last year. The latest news from this same island is, that the queen has received our consul with cordiality, and professed a desire to remain in alliance with Queen Victoria as a means to her own well-being.

Complaints are frequently made of the antiquity of most of the maps of India. Several publishers have had good maps of India executed, but, like many other parts of the world, the frontiers of the various governments in the countries comprised under this general term have varied and extended so much of late years, that it is impossible to keep the whole world supplied with the latest information at a small cost. During the last twenty-five years the British frontier has advanced 1,000 miles, and the Russian territory is not only creeping onwards with steady strides at an almost equal rate, but the intermediate district is being traversed first by such men as M. Vámbéry, and afterwards by many English travellers, and that constant attendant of Englishmen, the red-bound Murray, is adding Central Asia to the almost world-encircling region mapped out and chalked out to be *done* by the energetic Englishman in search of excitement.

Mr. Ussher has published a very bulky and extensive work on Georgia, Kurdistan, Persia, and their neighbourhood, which throws much light on these countries. Thanks to M. Vámbéry, and others who have explored the districts bordering on his route, Central Asia will be before long as well known as Central Africa or Central Australia as exercising ground for scientific travellers. Mr. W. Gifford Palgrave, who has penetrated into previously unknown parts of Arabia, has been made Prussian consul at Bagdad.

Much attention has of late been attracted to Bhotan, and it is to be hoped that, if no other advantage accrue from the war now being waged in that territory, at least some geographical information and some good maps may result from it. The country is said to be in some parts adapted for the cultivation of tea, especially near the province of Assam. In a few years we may expect to find that it will be a matter of great doubt whether the tea we drink comes from that country which we have so long considered to have the monopoly of its growth. India already supplies a very large proportion of that which is drunk in England; and the colourless Japanese tea also finds not a few patrons. Englishmen are acquiring land in India for this purpose, and the natives are stirred up into some excitement by the demand for native tea, which is sold at a good profit, at 1*s.* 6*d.* a pound.

The district of Bhotan, or Bootan, to which we referred above, lies on the southern slope of the Himalayas, and includes some of the highest of these mountains, as, for instance, Chumulari, which is nearly 24,000 feet high. This district is 230 miles long, and 130 broad, and contains 19,000 square miles. Between the years 1772 and 1774 a slight collision took place between the Bhoteahs and the British; since that period little notice has been taken of the doings of these mountaineers, until their invasion of Assam and the subsequent maltreatment of Mr. Eden and his party. The military proceedings of the invading force at present have been confined to the taking of hill forts of some strength, defended with much courage by these mountaineers. The boundary towards the British possessions is not of a mountainous character, but rather marshy forest, such as would be called swamp* in America.

There is but little geographical news from Australia. The electric telegraph now connects all the principal colonies, running from Adelaide to Melbourne, thence through Sydney to Brisbane; and it is expected soon to reach Rockhampton, a town destined ere long to eclipse Brisbane, unless the latter makes great efforts to keep up the start it already possesses. We suppose Point Somerset and Cape York will be the next post; and when we have arrived thus far, we may hope for a fortnightly communication with the China mail before the latter reaches Calcutta. 'A History of the Discovery and Exploration of Australia' has been written by the Rev. Julian E. Tenison Woods, of the colony of Victory, a gentleman who adds innumerable letters to his name, and who has had great assistance in his work from governors of provinces, and others possessed of information on the subject on which he writes. The result is a dry but valuable account of the early history of the Continent, and of the latest discoveries in the interior. Amongst many valuable facts he mentions that Captain Flinders, in whose honour, as we mentioned in our last paper, the Australians have been so liberal in giving names of unconnected localities, received so little pecuniary liberality, and his surviving relatives have profited so little by his discoveries, that one of his nieces a short time since had to apply for an assisted passage to New South Wales. After the death of Flinders, there were no great discoverers in Australia until Sir Thomas Michell, in 1831. He was succeeded by Pyne, the present Sir George Grey of New Zealand, Leichhardt, Kennedy, the Gregorys, Austin, Babbage, Warburton, Macdouall Stuart, Burke, Wills, Walker, Landborough, McKinlay, and Howitt.

The work of one of the above travellers, Mr. Macdouall Stuart, called 'Explorations in Australia,' has been accepted by her Majesty and by the Prince of Wales, who thus ratify the name of "Alexandra Land" given by the discoverer to a portion of Northern Australia.

Several questions of topography, if not of Geography, will receive elucidation from the survey of Jerusalem and the Dead Sea, by the sappers under the command of Captain Wilson. Much has been done

* In the Western Continent the word "swamp" refers to the timber on the land, rather than the moisture of the soil itself.

by them, and as their work approaches completion more is found for them. The opportunity of having men who have had considerable experience in the trigonometrical survey of England in such localities is not to be passed over, and it is worth while expending a little additional money, which will surely be forthcoming for such an object, in procuring data from which accurate deductions may be made. Not only from religious and antiquarian motives must much interest be excited as regards such measurements, but natural science may expect some accessions of knowledge from the survey of the Valley of the Jordan and Dead Sea.

Mount Ætna, after a repose of thirty years, has commenced an eruption at some distance from its main crater. As yet but little damage has been done, but a very fertile district is threatened. Some lives have been lost through the explosion of water in the cisterns over which the lava has passed, and thus sealed before its heat has penetrated sufficiently to convert the contents into steam. The mountain gave warning of a coming eruption during a whole month beforehand, by a dense cloud of smoke which overhung it, the weather in the meantime becoming remarkably warm. The eruption, which began on the 31st of January, runs down the eastern side in three principal streams, which separate into several branches as they proceed. Amongst other points threatened is the famous chestnut-tree "of the hundred horsemen." It is rather remarkable that the neighbouring volcano of Vesuvius has also manifested disturbance about the same time. On the 9th of February a cone was raised, red-hot stones were thrown out, and shocks were produced which were felt in Naples. It is seldom that two of these safety-valves of under-ground disturbances exhibit activity at the same time. Probably, however, this disturbance at Vesuvius is only a reflex of the occurrences at Ætna, and not to be accounted a distinct eruption.

The Royal Geographical Society.

Since our last notice of the proceedings of this Society a very interesting paper has been read by Mr. J. G. Taylor, "Notes on a Visit to the Sources of the Tigris, with an Account of Ancient Remains found in their Neighbourhood." An exploration of countries so near Diarbekr and Kars scarcely promised to be a highly interesting subject, but Mr. Taylor observed two matters which have not been remarked on previously. Sir H. Rawlinson, previous to the departure of this traveller for the neighbourhood of the Upper Tigris, suggested that he should look in a certain locality for Assyrian remains, which Tiglath Pileser I. (about B.C. 1110) stated, in his records of his reign, that he had erected by the side of an inscription by a former king, who had laid waste the same country in bygone generations. Such memorials were entirely unknown to the inhabitants of the country, but, after a little perseverance on the part of Mr. Taylor, were discovered by him on the site indicated. This affords a remarkable confirmation of the truth of the interpretation put upon the cuneiform

characters of Assyria. The second interesting locality visited by Mr. Taylor was a cavern into which the Tigris plunges at a few miles from its source. It traverses about two miles under ground, and it is probable that formerly this distance may have been greater, as detached arches and masses of rock choke its passage at some distance from the tunnel, thus confirming the account of Strabo as to the extraordinary length of its passage under ground. Some of the sources of the Euphrates are within five miles of the Tigris,—here, as in many other instances, great rivers rise in adjacent localities, seldom, as in this case, to unite again near the termination of their course.

A paper was also read before the Society, which gave a description of "Lake Nor Tzai-san," near Berezoff in Siberia, near the boundaries of Russia and Chinese Tartary, written by M. A. Abramof, a resident at the former town. The lake is a fishing station of the Russians, and is visited yearly by a Chinese official, to whom a tribute of salt fish is presented.

The basins of large rivers form a subject of much more practical interest than the discovery of the source of the mightiest stream yet navigated; nevertheless the latter subject invariably attracts more attention, and has more of romance in it than a well-considered account of country drained by a really important means of communication between distant lands. A paper by Mr. Richard Temple, Chief Commissioner of the Central Provinces of India, "On the Basin of the River Mahanuddy," refers to a subject on which the writer is well able to speak from his official position, and forms, in fact, an abstract of the geographical portion of a report furnished to the Government; still, from its statistical and extremely practical character, it seems to have attracted little attention among scientific men. The district drained by this river system is very extensive, as the stream is navigable for 690 miles, thus forming a means of inland communication between a very extensive country, but unfortunately it does not open a road to the sea, since the mouth has silted up. This is the more unfortunate, as the district of Chutteesgurh, on the upper part of the river, is well adapted for the cultivation of cotton of a kind, it is said, superior to the majority of Indian produce. This climate causes it to be thus suited for growing cotton, as it has a moist atmosphere, and the copious rains keep the river at a regular height during a large portion of the year. This steady rain is induced by the hills surrounding the river valley, and thus irrigation is not required even for the sugar-cane. The corn crops are so great that of late years they have rotted in the stacks. In the upper part of the valley mangore swamps have encroached upon the old kingdom of a Rajpoot dynasty, which had its capital at Ruttunpoor. No other trees grow here, though lower down the forests are extensive, and large quantities of teak, and of a tree called the Sal-tree, are grown. This latter equals the Teak in durability and strength, but it requires several years to become thoroughly seasoned, and is consequently less valuable. Besides these elements of commercial enterprise, the valley affords both coal and iron in considerable abundance, which might be made available could the entrance of the river be opened to large vessels, which would

be possible at the expense of a little dredging, and by this means communication with the interior might be effected during the six months in the year when the water is highest. Until this is carried out it would be scarcely fair to the natives to induce them to cultivate cotton without means of getting it to European markets.

The same evening a paper was read from Dr. Bastian, a native of Bremen, on "A Visit to the Ruined Cities of Cambodia." The writer is still in that country, continuing his exploration of temples, bridges, and sculptures near *Thalesab*, or the Sweet-water Lake. He has found numerous inscriptions on the temples, and hopes in time to throw some light on the history of this country, a subject all the more interesting as the actual documents still in existence extend back but a short distance, all that were older having been consumed by fire.

During a dearth of other subjects, Captain Sherard Osborn, R.N., has excited the flagging interest of the Geographical Society by bringing before it the topic of Arctic exploration. He considers that we should not rest upon what has been done; that though the immediate object of former voyages, *viz.* the discovery of a north-west passage, has been gained, and that one problem has been solved, there are many more, though not of such commercial advantage as this was supposed to be in the days in which the idea was first started, still of vast scientific value—problems which ought to lead adventurous spirits to attempt, and scientific men to foster the attempt, to reach the North Pole. The leading difficulty anticipated was the opposition raised by many to what they might consider a dangerous and a useless employment of Government resources. This Captain Osborn met by showing that such an expedition is neither dangerous nor useless. During the period between 1818 and 1854 only two ships and 128 men had been lost out of forty-two exploring parties. In no part of the world had so large a surface been mapped out at so small a sacrifice of human life, and no expeditions were so popular among the common sailors as these northwards. The advantages to physical science accruing from well-directed observation in extreme latitudes promise to be exceedingly great. The mysteries of the Gulf-stream and the Ice-stream lie hidden in the abysses of the Arctic Ocean—if it exist; whether the Pole be surrounded by earth, ice, or water, is still unknown, and conclusive arguments in favour of each theory are put forth. The magnetic pole has been visited, and lengthy observations in its immediate neighbourhood have led to many modifications of our opinions on subjects connected with the needle, and especially have elucidated the dip. No voyage northwards has been undertaken but it has afforded some materials for starting new theories or correcting old ones. Grant, then, that an expedition is desirable, the next question is the route to be taken. Two principal ones strike the mind at once—one by Spitzbergen, between Greenland and the American islands, the other by Smith's Sound. The former is proposed by Dr. Peterman, the latter by Captain Osborn. By the former way sailing-ships have gone within 500 miles of the Pole, and Captain Parry attained, on the night of 22nd July, 1827, to a point at an interval of only 435 geographical miles from the desired point. But north of Spitzbergen

no land is known to exist—according to Dr. Peterman, an advantage; according to Captain Osborn, a drawback, inasmuch as no fixed points for depositing provision can be depended on. Greenland is known to extend 120 miles nearer the Pole than Spitzbergen, and there is every probability that it runs much farther. As far as it has yet been traced, icebergs are observed to come down the coast, a sure indication of extensive glaciers, which, like rivers, their representatives in warmer regions, demand a great extent of land in order to become large. Besides, extensive mountains were seen by Mr. Morton to the north of the Humboldt glacier and Cape Constitution. We may well conclude, then, that land runs far north, and that expeditions might safely deposit their provisions for their return portion of the 968 miles' sledging, which would be all that would be required in order to go from Cape Parry to the Pole. Much more than this has been done on many occasions by arctic voyagers. Commander M'Clintock's party in 1853 went 1,220 miles in 105 days; Commander G. Richards, 1,012 miles in 102 days; Lieutenant Mecham, 1,203 miles; Captains Richards and Sherard Osborn, 1,093 miles; Lieutenant Hamilton, 1,150 miles, with a dog-sledge and one man; in 1854 Lieutenant Mecham, 1,157 miles in only 70 days; Lieutenant Young, 1,150 miles; and Captain M'Clintock, 1,330 miles.

One great source of interest in these journeys would be the manners and customs of any races living in these distant regions. Sir John Ross discovered a tribe, named by him Arctic Highlanders, in lat. 75° 35′. They were hearty, strong, well-made men. A well-fed and well-disposed tribe is known to exist in Smith's Sound, and traces of inhabitants have been found between Humboldt Glacier and Cape Constitution, though the Esquimaux know nothing beyond the former barrier. The condition, civilization, and customs of such people must be highly interesting, and might throw much light upon the period when our ancestors were dependent on stone and bone for their implements, and when our predecessors in this land were more closely allied to tribes in the far north than they are at present.

The means to such expeditions as are required for these purposes are not to be found, according to Captain Osborn, in private enterprise. It was this which ruined Dr. Kane's * attempt. It only requires sufficient pressure to be exerted by the scientific and educated world upon the Governments to induce them to fit out for this service some of those fine vessels which now lie rotting in our dockyards. Two small screw-steamers, with 120 officers and men, would not appear as a large item amongst the 50,000 men annually voted for the Navy; and such employment as this would be better training and less expensive of life and money than small warlike preparations against Ashantee, Japan, or New Zealand.

Besides the ethnological, geographical, and physical observations referred to above, there is one of great practical value,—the measurement of an arc of the meridian in these high latitudes. The speaker

* We would remind Captain Osborn that Sir L. M'Clintock's successful voyage was not under Government patronage.

appealed, therefore, to the President of the Society to second and forward his views in this matter—an appeal which elicited a hearty response from Sir Roderick Murchison, as well as from General Sabine, the President of the Royal Society, Mr. John Lubbock, the President of the Ethnological Society, and others. Of course a subject of this kind is received with various feelings, and this paper has excited much controversy and excitement beyond the rooms of this Society.

Dr. Augustus Petermann, an Honorary Corresponding Member of the Society, has addressed a communication to Sir Roderick Murchison, from Gotha, on the subject of Captain Sherard Osborn's paper. Whilst most anxious for the prosecution of discovery towards the North Pole by British seamen, he urges very strongly the route by way of Spitzbergen, in preference to that by Smith's Sound, for eight principal reasons:—The Spitzbergen route to the North Pole is (1) the shortest from Great Britain, (2) the widest ocean route, (3) most free from ice, (4) it offers only drift ice as an impediment, and this is least in spring and autumn, (5) the sea to the north of Spitzbergen cannot be frozen over owing to great currents, (6) Sir E. Parry reached within 465 miles of the Pole in open sea, which extended far to the north of his position, (7) all facts lead to the conclusion that under the Pole is open sea and not land, but if it should be land, this would easily be crossed in sledges from a ship, whereas a land party coming to sea would be checked entirely, (8) the cost of the journey would be less. Sir E. Parry's expedition from the Thames to 82° 40′ N. (the highest point yet reached) and back was only 9,977*l*.

Dr. Peterman supports his theory that the Pole is occupied by sea rather than land by many ingenious arguments, and in this theory he is backed by the opinion of Captain Maury. He quotes the result of all antartic exploration that a barrier of some five or ten degrees of ice is found, beyond which open sea is again reached. If this theory be true, the learned doctor's idea that a screw-steamer might take a trip to the North Pole and back in two or three months might be realized, thus making the cost insignificant. It is also said that not only might much scientific knowledge be added to our stores by such an expedition, but that also a great deal of information might be acquired that would be of the utmost value to the whale fishers. Should it be found possible to endorse this statement, but little comparative difficulty might be found in starting an expedition. At present a great deal of contention is going on as to possibility of inducing the Government to forward the plans of the Society. Of course much may be said on both sides. It is evidently not the province of the Government of a great nation to expend the money of that nation in purely scientific pursuits; at the same time all that has reference to the material well-being of the people must fall within the duties of those who receive the proceeds of taxation. That the honour of England is enhanced by the discoveries of her great men is true enough, but her honour is in the hands of voluntary societies. If it can be shown that some material advantage to a large mercantile class, such as our whale fishers, will result from an ex-

pedition to the North Pole, the guardians of the public purse are not likely to exact very demonstrative arguments or inquire too closely into the probable results, and thus the skeleton of an exploring party may be furnished with vessels no longer of any great value for warfare, but the chief expense of scientific apparatus, &c., will have to be furnished by the Royal, Royal Geographical, Ethnological, and other Societies.

The subject of his former paper having excited such great attention, and created so much discussion in various publications, Captain Sherard Osborn read an abstract of Dr. Peterman's paper at the meeting on the 27th of February, and then proceeded to combat to some extent his position that the route by Spitzbergen was the better one. Admitting that under the Pole there was water, he would not admit that it was all open sea over the 150 millions of square miles as yet unexplored. This was one of the points that it was desired to get at rest; but in either case it would be much safer, and would give a much surer hope of the return of any exploring party if they had to travel principally over dry ground. The number of men in the naval service who were anxious for employment of this kind was very large, and included men of all ranks, from admirals and those who had won their renown in these regions, down to those who had their laurels yet to gain. The sum expended by the nation on the navy was great; much had been spent in building vessels of war to suit the new wants of scientific warfare, yet the results were few, and the fighting vessels might be counted on the fingers, whilst but a small share of this large sum, only one 230th part during the last ten years, was expended on the scientific departments, and out of this money had been used for a cricket ground—hardly a scientific advantage. All who have taken part in the discussion of this subject admit that the risk to the lives of the explorers is diminished to a very great extent, and that former failures ought not to be made a standard by which to judge of the future.

On the same evening, at a later discussion of the expedition to the North Pole, an ingenius but rather speculative paper was read by the Secretary, Mr. Markham, "On the Origin and Migration of the Greenland Esquimaux." The Esquimaux were stated by this gentleman to have originated in Asia; to have found their way to the Parry Islands, how or when does not appear, though in these islands their traces are very numerous, and have been found by all arctic voyagers; and finally to have arrived at the northern part of Greenland. Here they divided into two parts, one going south and driving out the Norsemen who had previous to this colonized the south of Greenland as far as Upernavik; the other journeying northwards, and from that time to this being cut off from communion with the rest of humanity. To seek these distant offshoots of the human family is the object of the proposed expedition, and an account of their habits, manners, language, and mode of life would throw much light on the early history of the world, and probably on the condition of our ancestors in the earliest ages. Another portion of Mr. Markham's paper, which contained less theory and a more solid basis of facts,

was devoted to an historical sketch of Greenland from the time it was first colonized by Norsemen emigrants from Iceland, when trees grew on the hill sides and a milder climate clothed those desolate shores with a verdure which made them attractive to many a roving Scandinavian Viking. Two districts were once colonized in this manner; but the Esquimaux came, war ensued, but little or no intercourse took place between the mother-country and its puny offspring thrust forth into a cold world; a deep sleep seems to come over Iceland, and now all the remains of this once flourishing colony, or the still more distant voyagers to Vinland farther south, are a few Runic inscriptions on the coast of Greenland and some of the seaboard of Continental America, and a saga or two carefully stored away among the most interesting relics of the Society of Northern Antiquities at Copenhagen, published, or to be published, by the learned members of that body, who have done so much towards elucidating the early history of all branches of the Scandinavian family.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Palæontologists are now and then startled by some one proposing an interpretation of a fossil altogether at variance with that commonly current. Such views are often received with scant courtesy, and not unfrequently excite some amount of ridicule. But really earnest students of nature require little inducement to replace this sort of argument by one better calculated to establish truth and advance science, for palæontologists cannot but remember how many apparently *outré* opinions have afterwards turned out to be strictly correct. We doubt not, therefore, that the case we are about to record will receive in good time either confirmation or disproval from able hands.

A little pamphlet of 19 pages, by M. Sanno Solaro, a priest of the "Company of Jesus," has recently been published at Toulouse. It is entitled "Mémoire sur le premier bassin de *Dinotherium* découvert dans le département de la Haute-Garonne," and is illustrated by three quarto plates. In it is recorded the discovery of a number of remains of *Dinotherium* at Escanecrabe, in the said department, during the construction of a road from that place to Lilhac. Amongst them was an enormous pelvis, quarried out under the superintendence of the author himself; it measured about 6 feet across the crest of the iliac bones, was nearly complete, and evidently belonged to a huge *Dinotherium*.

Now we come to the remarkable point. At the side of the cotyloid cavity, M. Solaro discovered another, of a triangular form, containing the articular extremity of a small bone, which fitted into it. This he considers to be a portion of a marsupial bone, notwithstanding that it was articulated to the ilium instead of the anterior branch of the pubis, as in other marsupials.

The author ingeniously remarks that the head of the *Dinotherium* being so aberrant, the animal might almost be expected to possess other anomalous structures, and he suggests as an explanation of the position of the "marsupial bones," that had they been attached to the pubis the pouch would not have been large enough to receive the young, while their articulation to the iliac bones sufficiently accounts for the great lateral development of the latter.

The *Dinotherium* was considered to be allied to the Tapirs, by Cuvier; it was afterwards thought to be a Cetacean, until the discoveries of M. Lartet, when it took its place amongst the Pachyderms. Now, if M. Solaro be right, it must be considered a Pachydermatous Marsupial, approaching the *Nototherium* to some extent, but not in respect of the position of the marsupial bones. Again, if M. Solaro be right, the *Dinotherium* could not have been aquatic in its habits, for, as he remarks, its young would have been smothered in a few minutes after immersion.

The *Nototherium* was about the size of an ox; but the *Dinotherium* was as big as the largest species of elephant. It certainly requires a strong imagination to enable one to conceive the possibility of an animal of such colossal dimensions, with two huge tusks hanging from its lower jaw, carrying its young about in a pouch!

The Second Decade of Canadian Fossils, containing a Monograph of the *Graptolitidæ*, by Professor James Hall, is an important contribution to the literature of that curious group of fossils, for in addition to diagnoses of all the Canadian species, it contains a good description of their general anatomy, and a discussion on their affinities. Not long ago most palæontologists thought the latter question was at last settled in favour of the *Bryozoa*, so many high authorities having given their support to that view; and the discovery of a basal plate in certain species seemed to provide the only wanting link, namely, the presence, in some of the Graptolites of a structure known to occur in *Bryozoa* and not in *Hydrozoa.* In the introductory chapter to this decade, however, Professor James Hall, who is perhaps the most celebrated of the American palæontologists, describes *external* organs of reproduction, consisting of ovarian vesicles, situated on the stipe of the Graptolite, very much as similar organs occur on the stems of recent *Sertularidæ.* This is the second time, at least, that Professor Hall has stated his conviction of the ovarian character of these sacs, and if his opinion be well founded, the affinity of the *Graptolitidæ* to the Sertularians can no longer be contested. Professor Hall has satisfied himself that the "ovarian vesicles" were really attached to the stipe, and originated from it; he has also found young Graptolites of extremely minute proportions, and in all stages of development, "near to and in contact with the reproductive sac, and in one case there is but a hair's breadth between one of the fibres of the sac and one of the oblique processes at the base of the germ." The function of this "reproductive sac, or ovarian vesicle," therefore appears pretty certain, and consequently the Hydrozoan nature of Graptolites seems equally so.

One of the most paradoxical members of the series of sedimentary

rocks is the formation known as the St. Cassian Beds. According to all geologists who have studied their position and stratigraphical relations, they lie *above* the Muschelkalk; but their fossils partly belong to genera otherwise Palæozoic, and for the most part have a much *older* facies than those of the underlying deposit, which are, to all intents and purposes, of a Mesozoic type. It appears, however, that this character of the St. Cassian fauna has been too much taken for granted, and that the assertion of the fact by the older geologists meeting with no contradiction (perhaps because it was well founded), the anomaly has been much over-rated in value. Dr. C. Gustav Laube has recently undertaken the examination of the whole St. Cassian fauna, so that we may shortly expect to have the matter placed in a rather different light than hitherto. The first part of his work, which is entitled 'Fauna der Schichten von St. Cassian,' has just been published, and appears of great promise, for his investigations have yielded, so far, some curious results. This first instalment includes the description of the Sponges, Corals, Crinoids, and Echinoderms, comprising 115 species, of which 33, or nearly 30 per cent. (quite sufficient to change the facies of a fauna), are new. Many of the species belong to genera which have not hitherto been known in rocks older than the Jurassic, so that if the evidence of the Mollusca turns out to be on the same side there will be comparatively few anomalies to explain. One very important determination is, that the Encrinite hitherto supposed to be identical with *Encrinus liliiformis*, Schl., a Muschelkalk species, differs considerably from it, and is a new and very distinct species.

Amongst the many proofs that Geology is becoming day by day more popular as a recreative study, we may point to the large and increasing number of local Geological Societies. Very many of the larger towns can now boast of a Geological Society, and several other towns and districts have a Field Club, or Natural History Society, in which Geology either forms a separate section (as at Bristol) or else monopolizes a large share of the general attention. Some of the Societies and Field Clubs were started many years ago, and have led a very languishing life until recently, when they seemed to take "a fresh lease," as it were. We have no space to enter into a discussion of the causes of this revival of scientific energy; but shall content ourselves with briefly noticing some two or three of the best provincial Geological Societies, just mentioning by way of contrast, and on the grounds of impartiality, that we were lately assured that in a certain provincial town, of forty thousand inhabitants, there were only *two* people at all likely to take in the "Geological Magazine," or to read it for any consideration short of actual payment!

The Geological Societies of Liverpool, Glasgow, and Manchester, and the Royal Geological Society of Cornwall, are amongst the most flourishing. Perhaps that of Manchester has been the most successful, though the Royal Geological Society of Cornwall has been the longest established, and has published the most important works. The Liverpool Geological Society is comparatively of recent origin; we have just received the Abstract of the Proceedings of its Fifth Session (1863-64): it appears very creditable to the Society and the

Secretary, and it contains three very good papers—by Mr. Morton (the Secretary), Mr. Hicks (of *Paradoxides* fame), and Mr. Davies (of Oswestry). The Glasgow Geological Society publishes a similar volume, and full reports of the meetings are also sent to local newspapers; this is one of the reorganized Societies, and has at least one good feature peculiar to itself, namely, the delivery of monthly "Lectures," in addition to holding the usual ordinary meetings. We have read the Report of Dr. Machattie's Lecture, "On Metamorphism, with special reference to the chemical changes in Rocks," with a great deal of pleasure, and we cannot help thinking the Glasgow geologists remarkably fortunate, especially if the Lectures are always as good as this one. Mr. Dougall's paper, "On ancient sea-margins around Glasgow," read at the previous meeting, is certainly above the average in merit and care. The Dudley and Midland Geological Society is also of recent formation, and its "Proceedings," which we acknowledged in our last Number, will be dealt with on a future occasion along with those of other provincial societies.

The Royal Geological Society of Ireland, and the Geological Society of Edinburgh cannot properly be called provincial societies; but the last Number of the Journal of the former, then known as the Geological Society of Dublin, contains a paper which deserves special notice. This paper is by Mr. Sterry Hunt, and is "On the Chemical and Mineralogical Relations of Metamorphic Rocks." The interesting question discussed is, "Whether, in the absence of organic remains, or of stratigraphical evidence, there exists any means of determining, even approximately, the geological age of a given series of crystalline stratified rocks; in other words, whether the chemical conditions, which have presided over the formation of sedimentary rocks, have so far varied, in the course of ages, as to impress upon these rocks marked chemical and mineralogical differences." This is certainly one of the largest questions that could possibly be opened out for discussion. Are metamorphic rocks characterized by minerals as unaltered rocks are by fossils? Most people would very readily give an answer in the negative without being able to support their opinion by facts of importance. But, on the other hand, Mr. Sterry Hunt brings forward a sufficient number of facts to prove that the subject is a fair one for inquiry. No one now believes in unmeaning coincidences, though it would be difficult to prove, or even to suggest, a rational interpretation of very many of them. The author's suggestion seems, however, to promise well, and we hope that investigators will keep the problem in mind. What is meant, for instance, by the similarity of the blue crystalline Labradorite of the Upper Laurentian rocks of Canada to the similar mineral occurring in Skye, if not contemporaneity of the rocks in which they occur? Again, many serpentines in distant countries agree in containing chrome and nickel, while others, as those of the Scandinavian primitive gneiss formation, are destitute of those minerals; now there is sufficient collateral evidence to render probable the synchronism of the former group, while the latter is known to be much more ancient, so that here we seem to have a case in point. Still, it must be remembered, that isolated

cases like these, even if their meaning were more clear, are not sufficient to prove a law of such paramount importance, and as Mr. Sterry Hunt remarks, "it remains to be determined how far chemical and mineralogical differences, such as those which have been here indicated, are geological constants."

The 'Geological Magazine' has been quite as good as usual during the past quarter, having contained much that is instructive, with occasionally something amusing. Papers of sterling worth have been as abundant as before, and all the better for not being quite so technical. We may specially mention Professor Owen's description of *Anthrakerpeton crassosteum*, a new air-breathing reptile of low organization from the Coal-measures of Llantrissent, Glamorganshire; Mr. C. B. Rose's paper "On the Brick-earth of the Nar," in which he states his conviction of the approximate synchronism of that deposit with the Post-tertiary beds of the Clyde basin, and records Dr. Otto Torell's identification of several of the Nar shells with some of those found in the raised beds at Uddevalla; Mr. Seeley's paper "On the Neck-bones of a new Fossil Whale from near Ely," which the author states were derived from the Kimmeridge or the Oxford clay, although the oldest English whales hitherto known have been found in the Crag; and lastly, Mr. Handel Cossham's description of the geological structure of Kingswood Hill, in the course of which he shows that the rock mapped as Millstone-grit by the Geological Survey is merely a particular bed of sandstone (known as the "Holmes Rock") occurring in the Coal-measures, and that therefore coal exists (as he has proved by actual mining operations) where, if the Survey-maps were correct, it would be hopeless to look for it.

Two other papers come into another category—one by Sir Roderick Murchison, in which he quarrels with Sir Charles Lyell for stating that the gneiss of the north-west of Scotland and of the Hebrides has been *conjectured* to correspond with the Laurentian rocks of Canada. Sir Roderick says that he has *proved* it, not only for the Scotch gneiss but also for the old gneiss of Bavaria and Bohemia. What may be "proof" to the mind of one of these distinguished men, may conceivably, in a Science like Geology, be no more than a "conjecture" to that of the other. We know that everyone believes in his own theories. The other paper is vastly entertaining, and not a little remarkable; it is by Mr. Ruskin, and is entitled "Notes on the Shape and Structure of some parts of the Alps with reference to Denudation." It is so entirely *sui generis*, that we can scarcely hope to give an adequate idea of it, except by a reprint. However, we subjoin a few extracts, with explanations. Mr. Ruskin begins with the following odd notion:—"It is often said that controversies advance Science; I believe, on the contrary, that they retard it—that they are wholly mischievous—and that all good scientific work is done in silence, till done completely." Believing this, he at once acts contrary to his belief by becoming a partisan in the question of glacier-erosion, arguing the matter in his own peculiar way, after the manner of an exaggerated *reductio ad absurdum*. Thus: "Where would be the harm of granting it for peace sake, even in its complete expansion? There were, we

will suppose, rotatory glaciers—whirlpools of ecstatic ice, like whirling dervishes, which excavated hollows in the Alps," and so on. Again, "Gigantic glaciers in oscillation, like handsaws, severed the main ridge of the Alps," &c. Professor Ramsay and his followers do not require any such ridiculous suppositions in support of their views; and, although we are no advocate of their theory, we submit that Mr. Ruskin has not argued against it in a proper manner or a proper spirit. He should rather, on account of his own reputation, have stuck to the text with which he began; for if scientific controversy is mischievous, the burlesque of it is much more so. The following paragraph, with which we must conclude, is perhaps the most amusing in the paper. "The lakes of Maggiore, of Como, and Garda, are similar excavations by minor fury of ice-foam;—the Adriatic was excavated by the great glacier of Lombardy;—the Black Sea by the ice of Caucasus before Prometheus stole fire;—the Baltic by that of the Dovrefeldt, in the youth of Thor;—and Fleet Ditch, in the days of the 'Dunciad,' by the snows of Snow Hill. Be it all so; but when all *is* so, there still was a Snow Hill for the snows to come down."

The admission of this remarkable paper, *for the sake of catching a great name*, into a Scientific Journal, which should be most particularly anxious to look to *measures* and not to men, is an apt illustration of one of the growing evils of the day, for which, not editors, but the reading public, must be held responsible.

Palæontology has recently sustained a most serious loss by the death of Dr. Hugh Falconer, one of the greatest Palæontologists that ever lived. His death will be felt the more on account of his published works containing a mere fraction of the knowledge he possessed. Before he died, Geology and Palæontology were in a much more advanced state than they can now be said to be, for though he wrote little, he spoke frequently, and his opinion on Palæontological subjects was rightly deemed of the utmost value, partly from his knowledge, and partly from his caution. Now all this is lost to us, and much more also, especially the salutary check which the fear of his playful banter and scathing satire put upon the thoughtless tongues and hasty pens of younger men.

Proceedings of the Geological Society.

No less than five papers in the last Number of the Geological Society's 'Quarterly Journal' are devoted to the Laurentian Formation and its contents. This subject has recently acquired immense importance from the discovery of *Eozoön Canadense* in rocks of that age in Canada, so that in this chronicle we shall not be able to give any account of the other two highly interesting memoirs in the same number, namely, "On the Geology and Fossils of Jamaica," by Dr. P. Martin Duncan and Mr. G. P. Wall, and "On the Correlation of the Cretaceous Formations of the North-East of Ireland," by Mr. Ralph Tate.

The titles of the papers relating to the Laurentian Formation and its Fossils are as follows :—

1. "On the Occurrence of Organic Remains in the Laurentian Rocks of Canada." By Sir W. E. Logan.
2. "On the Structure of certain Organic Remains in the Laurentian Limestones of Canada." By Dr. J. W. Dawson.
3. "On the Structure and Affinities of *Eozoön Canadense*." By Dr. W. B. Carpenter.
4. "On the Mineralogy of certain Organic Remains from the Laurentian Rocks of Canada." By Mr. T. Sterry Hunt.
5. "On the Geological Structure of the Malvern Hills and adjacent Districts." By Dr. Harvey B. Holl.

The discovery of the *Eozoön* has been already recorded in this Journal; * a notice of the stratigraphical position and almost inconceivable antiquity of the beds in which it was found was given at the same time. Consequently, of the five papers, it will not be necessary to refer more than incidentally to Sir William Logan's, and our space will not allow us to enter very fully into the points discussed by Dr. Holl and Mr. Sterry Hunt, as the chief interest is centred in the descriptions of the structure, and the discussions on the affinities of the fossil by Dr. Dawson and Dr. Carpenter.

In place of the strictly technical descriptions of these distinguished observers, we give the following more popular digest of their remarks on the structure of *Eozoön*, in understanding which the reader will be assisted by the woodcuts on the next page.

In general appearance (*see* Fig. 1), were it not for the materials composing it, many specimens of *Eozoön* might be mistaken for gneiss, as it consists of more or less contorted laminæ, generally coarser in one direction—probably towards the surface. In Fig. 1, the white stripes represent the walls of the chambers, &c., and the dark ones the chambers themselves filled with an infiltrated magnesian silicate. In the diagram (Fig. 2), it will be seen that the walls (B, B) of the chambers (A^1, A^2) are perforated by a number of minute canals, which give them under the microscope the appearance of a fringe of acicular crystal, the canals being now filled with the same material as the chambers. As the chambers grew old a thick calcareous shield, or stony epidermis (C, C), called a "supplemental or intermediate skeleton," was sometimes formed outside the "proper wall" (B, B, just described) of the chambers. When this occurred, the next layer of chambers (A_2, A_2) was not in immediate contact with the previous one, being separated from it by the "supplemental skeleton," but at the same time connected with it by means of "stolons" (D), and a canal-system (E). The individual chambers of the *same* layer either open directly into one another (as at *a*, *a*), or communicate with one another by passages through a shelly partition (as at *b*). There was thus a free communication between the different chambers of the same layer, and between certain chambers of different layers.

* Vol. i. p. 475.

FIGS. 1–3. *Illustrating the Structure of Eozoön Canadense.**

FIG. 1.

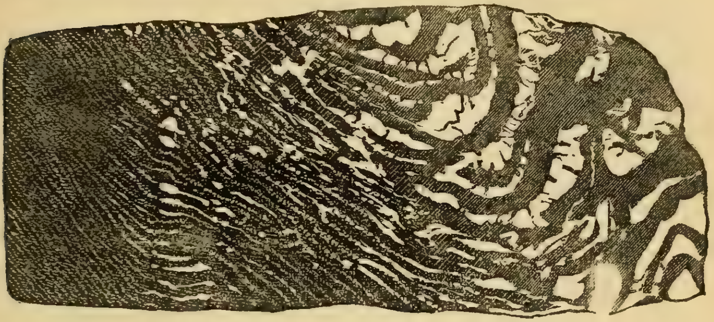


FIG. 2.

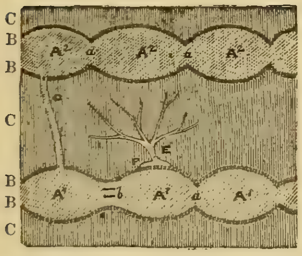


FIG. 3.

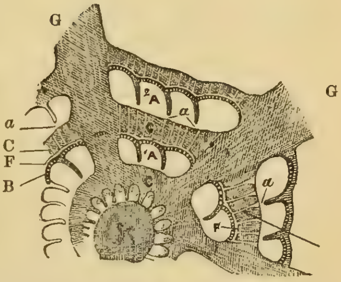


FIG. 1. Portion of a specimen of *Eozoön Canadense* from Burgess. Natural size. The white layers are dolomite; the black layers are dark-green loganite.

FIG. 2. Diagram explanatory of the structure of *Eozoön Canadense.*

A^1, A^1, A^1. Three chambers of one layer, communicating with each other directly at *a*, and by three passages through a shelly partition at *b*.

A^2, A^2, A^2. Three chambers of a more superficial layer.

B, B, B. Proper wall of the chambers, composed of finely tubular shell-substance.

C, C, C. Intermediate or supplemental skeleton, traversed by D, D, a stolon of communication between two chambers of different layers, and by E, canal-system originating in the lacunar space F.

FIG. 3. Section of the disc and radiating outgrowths (G) of *Calcarina.* The remaining letters occurring in this Figure have the same signification as in Fig. 2.

These structural features are found only in *Foraminifera*, and if we consider the *Eozoön* to belong to that class of animals, their interpretation becomes easy. The body of Foraminifera consists of the protoplasmic substance termed "sarcode;" it is soft, almost homogeneous, and remarkably plastic: it fills the chambers, is thrust through the innumerable canals in the "proper wall" of the chambers in the form of pseudopodia, and is present in all the cavities of the shell of the animal. The sarcode in the "stolons" and in the canal-system of the "supplemental skeleton" thus connects the sarcode of

* Figs. 1 and 2 have been copied from the 'Quarterly Journal of the Geological Society,' No. 81; Fig. 3 has been adapted from pl. xiv., fig. 4, of Carpenter's 'Introduction to the Study of the Foraminifera.'

the different layers of chambers, and enables the more deeply-seated portions to receive nourishment.

There appears, therefore, to be no doubt of the correctness of Dr. Dawson's determination of the Foraminiferal affinities of *Eozoön*; but we must refer to Dr. Carpenter's paper for a determination of the family of *Foraminifera* to which it is most nearly related.

Dr. Carpenter says that the structure of the "proper wall of the chambers" is so similar to that of recent and fossil Nummulites, that he finds no difficulty in placing *Eozoön* in the Nummuline series, notwithstanding its zoophytic plan of growth (*see* Fig. 1). But he observes that it presents also certain resemblances to *Calcarina*, especially in the mode in which the canal-system traversing the supplemental skeleton originates, namely, in lacunar spaces on the *outside* of the proper walls of the chambers (Fig. 2, F, and Fig. 3, F), and that it exhibits structures of minor importance, characteristic of some other genera. It should also be mentioned that, according to Dr. Dawson, the *Eozoön* probably grew in reefs, like the Corals of the present day.

We have given in Fig. 3 a diagram of the genus *Calcarina* for comparison with that of *Eozoön*, because we have found it easier to show the parallelism of the latter to recent *Foraminifera* by so doing than by giving a diagram of *Nummulina*, its nearest ally. It will be seen at once, however, that the structure of the "proper wall" of the chambers is different in *Calcarina* from what it is in *Eozoön*, and this is considered to be a more important diagnostic character than the presence or absence of a "supplemental skeleton," that structure being rather inconstant in its occurrence. Therefore, it must not be supposed that the relation of *Eozoön* is so close to *Calcarina* as to *Nummulina*, although the former appears to us better adapted than the latter for a popular comparison. In Figs. 2 and 3 we have indicated equivalent structures by the same letters, so as to render the comparison as easy as possible.

Sir William Logan contended for the organic nature of the *Eozoön* several years ago; but, as no microscopic structure could then be made out, his opinion did not receive much countenance; and when, in 1862, he brought some specimens to England, Professor Ramsay was the only English geologist who coincided with him. His energy, perseverance, and liberality under such discouraging circumstances, have excited the admiration of all, and we congratulate him most heartily on the magnificent result they have been the chief instrument in producing. The discovery of microscopic structure in specimens from another locality soon placed the matter beyond all doubt; these specimens were submitted to Dr. Dawson, and to him the credit is due of having first determined the Foraminiferal nature of the *Eozoön*. A more perfect series of specimens was finally submitted to Dr. Carpenter, who was thus enabled to corroborate Dr. Dawson's conclusions, as far as they went, and to extend very considerably our knowledge of the minute structure of the fossil. To Dr. Carpenter, also, is due the credit of determining the Nummuline affinities of *Eozoön*, and of making out clearly the exact nature and physiological meaning

of several points in its organization. Mr. Sterry Hunt, who has long argued, from mineralogical considerations, for the existence of organisms during the Laurentian period, has also done much to assist in the determination of the organic nature of *Eozoön*, and his paper on its mineralogy supplies much information on the probable mode of its preservation, and on the composition of the minerals (magnesian silicates) which have replaced the organic sarcode of the animal. These minerals, he thinks, were formed "by reactions going on at the earth's surface," and "not by subsequent metamorphism in deeply-buried sediments."

When we remember the great antiquity of the fossil, and the highly metamorphic character of the rocks in which it was found, this determination of the affinities of *Eozoön* cannot but excite our admiration, both on account of the skill with which the microscope has been made to reveal its structure, and the knowledge and patience applied to the interpretation of it, by Dr. Dawson and Dr. Carpenter; and the results more than atone for the small amount of romancing contained in their respective perorations. Dr. Carpenter's romance is perfectly harmless, and relates merely to powerful microscopes and little pins' heads; but Dr. Dawson's contains a lump of the old leaven of geological dogmatism, where it would least of all be expected. After describing an organism, perhaps as much older than the oldest Palæozoic fossil, as the latter is than the newest Tertiary, he reminds us of General Grant's "last ditch," by speculating on the probability of our having *at last* "the records of the first appearance of animal life on our planet." If the history of Geology did not furnish a sufficient number of proofs of the futility of such speculations, surely the discovery of the *Eozoön* ought to have supplied all that was wanting.

The anticipation of the authors of these papers, that their researches will form but the commencement of a long series of similar investigations, has already begun to be fulfilled, Mr. W. A. Sanford having discovered the *Eozoön* in Connemara Marble from the Binabola Mountains (*see* 'Geological Magazine,' February, p. 87). In a note to Mr. Sanford's communication, Professor T. R. Jones corroborates that gentleman's determination, and states definitely, in regard to the relationship of the Irish fossil to the Canadian, that "there is no real difference between the two."

Dr. Holl's paper "On the Malvern Hills" is an important contribution to British Geology. Its chief object is to prove that the rocks in that region hitherto termed "Syenite," &c., so far from being of igneous origin, are really metamorphosed sedimentary deposits, and that they belong to the great Pre-Cambrian or Laurentian formation. But, in addition to this principal feature, the paper is an almost complete treatise on the Geology of the Malvern Hills, and does infinite credit to its author, who has had opportunities of studying the aboriginal Laurentian rocks in their colonial home, and is, therefore, well qualified to judge of their similarity to the so-called eruptive rocks of the Malvern Hills. The arguments used by Dr. Holl in support of his chief conclusion are very strong; as an example, we quote the

following, drawn from the occurrence of a felspar with a small proportion of silica in crystalline rocks containing free quartz:—

> "As this felspar occurs in rocks which contain uncombined silica in the form of quartz, as well as in those that do not, and as the ratio of its soda and lime, alumina, and silica, is as 1 : 1 : 3, nearly, we are justified, I think, in concluding that it could never have co-existed in a completely melted condition along with free silica, also in a state of fusion, or it would have entered into combination with the latter to form a felspar, like albite or orthoclase, in which the ratio is as 1 : 1 : 4; and we have thus confirmatory evidence that these rocks are not eruptive."

The Council of the Geological Society have this year awarded the Wollaston Gold Medal to Thomas Davidson, Esq., F.R.S., F.G.S., &c., for the highly important services he has rendered through many years to the science of Geology, by his critical and philosophical works on 'Fossil Brachiopoda;' and the Balance of the Proceeds of the Wollaston Donation-fund to J. W. Salter, Esq., F.G.S., &c., in recognition of his valuable services in the elucidation of Palæozoic Fossils, and to assist him in completing his Monograph of British Trilobites.

VIII. MINING, MINERALOGY, AND METALLURGY.

Mining.

It is seldom that Mining has been in so very unsatisfactory a state in this country as it is at present. From the large accumulation of stocks, the price of tin remains exceedingly low, and there are not half-a-dozen of the tin mines of Cornwall which are working with any profit. If this state of things continues, a great many must cease to work, and those which are kept in operation must be maintained at a considerable loss. The condition of things may be judged of from one or two statements lately made by the managers of important tin mines. Captain Charles Thomas, of Dolcoath mine, says—"The average price of tin credited to-day is 57*l*. 1*s*. the ton, or 5*l*. 9*s*. per ton less than the preceding six months, making a difference of 950*l*. on the whole amount credited to-day." The purser of Providence Mine remarks—"The average price of tin per ton received during the quarter was 5*l*. less than during the previous six months, or 12*l*. 10*s*. less than the average price for the last twelve years."

At Great Work, the decline has stopped all dividends, which would otherwise have been 12*l*. per share quarterly. We consider the present depression well worthy of record, since it will form a remarkable chapter in the history of our mines.

Our copper mines, too, are much depressed. The very large importations of copper from South America, from Cuba, and from Australia, interfere to a very serious extent with our own mines.

In many districts, especially in Derbyshire and at Alston Moor, the produce of our lead mines is falling off.

We have not yet been able to ascertain the produce of coal in this

country during 1864. We are informed, however, that it will be slightly less than the quantity produced in 1863. The production of iron ore has been large, and the make of iron somewhat in excess of the previous year.

Mr. Villiers announced in the House of Commons that the Bill which he intended to bring forward to make metalliferous mines ratable to the poor, would be postponed to the next Session. This had been determined on to avoid interfering in any way with an Inspection Bill, which is being prepared by the Mines Commission, and which we understand will shortly be brought into the House of Lords by the Chairman of that Commission. It is essential that some legislative measures should be brought into action for the purpose of checking the spread of carelessness which is evident in our metal mines.

From time to time, attempts have been made to use electricity as an illuminating agent in coal mines, especially in such as produced so large an amount of fire-damp as to be dangerous. As the electric arc could be maintained in vacuum, or in a vessel of water—and, as the luminous current could be instantly stopped by breaking connection with the battery,—it was thought to possess elements of safety which belong to no other method. Not one of the numerous trials which were made was successful, and the idea was abandoned. The induction coil of Rhumkorff appeared, however, to open the question anew; and, when the beautiful phenomena of electric illumination in the rarefied media of Geiseler's tubes had been witnessed, the possibility of having light without heat, and consequently of forming a perfect safety-lamp was evident.

MM. Dumas and Benoît have constructed an electric lamp, founded on the advantages presented by Rhumkorff's machine, and Geiseler's tube, and they have made some trials with the lamp in several of the French collieries, which are stated to have been successful. It will be interesting to describe this lamp. The electricity is generated by a modification of the old bichromate of potash battery, consisting simply of a zinc vessel, a porous cylinder, and a roll of carbon, charged with a solution of the bichromate of potash, and dilute sulphuric acid. This arrangement is carefully secured in a case, with a wooden cover, made to fit tightly by means of India-rubber. Next, there is a Rhumkorff's coil and condenser, placed in a stout leather case, and then the Geiseler tube, which is very slender, and for the purpose of getting the largest possible amount of surface is arranged as a conical coil. This delicate tube is enclosed in a case of thick glass, protected by a suitable metal framework. It will now be understood that the lamp consists of three parts—the battery, the coil machine, and the tube—the whole together weighing about fourteen pounds. By means of straps, this apparatus is arranged around the miner, and provisions have been made by the inventors by which he may be relieved of this weight, and the tube used at a distance from the battery and the coil.

There can be no doubt but under circumstances of extreme danger, that this lamp may be useful. An explosive atmosphere may be

entered in safety, with the advantage of having a sufficient light for examination. It must not be thought that anything approaching to the brilliancy of the electric light proper is obtainable. When the excited coil is brought in connection, by means of wires, with the Geiseler tube, into the ends of which pieces of platinum wire are hermetically sealed, it is filled with a rich phosphorescent glow, resembling in its nature the auroral light.

The weight of the apparatus,—the inconvenience which must ever arise from the use of a voltaic battery, with its two fluids,—the precautions necessary to ensure the perfect action of the induction coil,—and the delicacy of the Geiseler tube, are difficulties in the way of this lamp, which must prevent its use under the ordinary conditions of colliery labour; but there are extraordinary cases constantly arising in our "fiery" collieries, in which it may be advantageous to introduce this lamp so ingeniously arranged by Dumas and Benoît. The Institute of France has given the inventors "an encouragement" of 1,000 francs for this application of electricity, stating its advantages to be, that it afforded the means of giving succour to miners in danger of perishing from the effects of fire-damp or of the "after-damp."

M. Alphonso Dumas attended a meeting of the North of England Institute of Mining Engineers on Saturday the 4th of February, to exhibit his lamp. The light was said to cost one penny for ten working hours. The President said the inventor had no idea of his lamp superseding the Davy lamp; but merely hoped that it might be useful in places of extreme danger. Mr. Easton said the principle of a phosphoric light was not entirely new. He had heard of stale fish having been used for the purpose.

Mr. Samuel Plimsoll, a gentleman connected with the South Yorkshire coal trade and that of London, has communicated to Dr. Allen, of the Philosophical Society of Sheffield, and Mr. Peacock, the Secretary of the Coal Owners' Association, his ideas on certain plans by which he supposed the presence of carburetted hydrogen may always be visibly indicated to the miner in the galleries of any colliery. From Mr. Plimsoll's statement, which includes many subjects having but small relation to Fire Damp, we gather, that he supposes the light carburetted hydrogen of the coal mines to exist only in the upper parts of the galleries; therefore, he would have a tube open at both ends, protected from currents by boxes. In this he would place a small balloon of gold-beater's skin, filled with the lighter gas—this bag would float on the common air, but would not rise into the carburetted hydrogen—and thus he conceives there would be a regular indicator of the quantity of gas in any place where the tube might be placed. This apparatus is so simple, that there can be no difficulty in trying the experiment. We fear Mr. Plimsoll has entirely forgotten the law of the diffusion of gases, which is often very rapid in its operation; but we shall hear more of this if it proves of any value. Mr. Plimsoll proposes also the application of some chemical means to register the presence of fire-damp. We heartily desire that he may be successful in his efforts to discover a safe and easy plan for determining this question, and then direct his attention to the improvement

of the means by which the source of danger may be removed. One thing should be steadily borne in mind. Men who will tamper with a safety lamp are not to be trusted with delicate apparatus, or with observing it, if placed beyond the danger of their handling. This tube and its balloon cannot be seen without the use of a lamp, and the flame of the lamp is a far more delicate indicator of fire-damp than any other at present known.

Amongst the numerous safety-chairs exhibited at the International Exhibition of 1862, none attracted so much attention as that of Mr. J. T. Calow, of Staveley. It has been thought so highly of by practical men, that a company, 'The Patent Safety Chair Company,' is formed for bringing it into more general use.

Mineralogy.

From some interesting papers "On the Mineralogy of South America," by Mr. David Forbes, F.R.S., we take a few notes.*

Bismuth.—This metal occurs in the native state as well as in combination with oxygen, sulphur, and tellurium, in a small vein in the Lower Silurian clay slates of the mountain Illampur, in Bolivia. The mine of San Baldomero opened upon this vein, is situated but little under the line of perpetual snow, and has an elevation of between 14,000 and 15,000 feet above the level of the sea. The analysis of the native bismuth gave *Bismuth* 94·46, *Tellurium* 5·09, *Gold a trace*, *Arsenic* 0·38, *Sulphur* 0·07. The ore Bismuthine gave Bismuth 80·93, Sulphur 19·61.

Mispickel was found in the same mine, as was also *Danaite*. *Nickeliferous Mispickel* is found in a vein in the Lower Silurian slates in the Corderillas, between La Paz and Yongas, in Bolivia.

Antimonial Galena.—Of this ore considerable veins are worked near La Paz, and are worked chiefly for the amount of silver contained in them.

Gold was discovered by Mr. Forbes in several places in Bolivia; amongst others, at Ancota, Playa Gritada, Romanplaya, and the valley of Tipuani.

The composition of the specimens was as follows:—

	Tipuani.	Romanplaya.	Playagritada.	Ancota.
Gold . . .	91·96	94·189	93·51	94·73
Silver . . .	7·47	5·811	6·49	5·23
Iron . . .	Trace	..	..	0·04
Matrix . .	0·57	..	..	..

Tin.—The discovery of metallic tin may be regarded as amongst the most curious fact recorded. It has been stated by others that tin has been found in the metallic state, but the correctness of this has been doubted. Mr. David Forbes appears to have taken every precaution to avoid being deceived, and he assures us of the discovery of a piece

* 'Philosophical Magazine,' vol. xxix., Nos. 193 and 194.

of metallic tin weighing 505 grains, at Oruro, in Bolivia. The analyses made gave the following general result:—

Tin	79·52
Lead	19·71
Copper	0·09
Iron	0·19
Arsenic	Trace
Insoluble Gangue	0·49
	100·00

M. A. Rivière has recently published a new treatise on Mineralogy, which from its completeness, we can strongly recommend to the students of this Science. He treats very fully the *Constitution of Minerals*, their *Properties, Physical and Chemical Characters*, and he gives a valuable chapter on the *Relations between the Crystalline Form and the Chemical Composition of Minerals.**

M. Marc Delafontaine communicates "Matériaux pour servir à l'Histoire des Métaux de la Cérite et de la Gadolinite," to the 'Bibliothèque Universelle.'† The more recent communication upon Terbia and Yttria enters fully into the examination of these earths by spectrum analysis, and brings forward several new and important facts. In the same manner Didymium, Erbium, and Terbium are examined, and in a note "Sur les Carbures des Métaux Yttro-Cériques," some curious chemical reactions are described.

In an ancient Celtic tomb at Mané-er-H'roek, in Lockmariaguer, in the Province of Morbihan, has been found a mineral much resembling the turquoise. This mineral had evidently been used like the turquoise, for ornament by some savage tribe once inhabiting this district. It has been examined by M. A. Damour, who finds it to consist of—

Phosphoric Acid	0·4258
Alumina	0·2957
Oxide of Iron	0·0182
Lime	0·0070
Oxide of Manganese	Traces
Water	0·2362
Silicious residue	0·0210
	1·0039

Differing as this mineral does, in the proportions of its principal constituents, and in its exterior character, from the turquoise, M. Damour proposes to distinguish it by the name of *Callais.* Many mineralogists distinguish the turquoise by the name of *Calaite*; Pliny having described a similar stone under the name of *Callais.* Damour desires to restrict the name of *turquoise* to the well-known precious stone, and

* 'Précis de Minéralogie, comprenant les Principes de cette Science; la Description des Minéraux et des Roches, leurs principaux Usages, &c.' Paris: Firmin Didot, Frères, Fils et Cie.

† 'Archives des Sciences Physiques et Naturelles.' Geneva. No. 85. January, 1865.

give that of *Callais* to this stone, which somewhat resembles it.* M. Damour supposes this mineral must have been brought from the East; but, at a more recent *séance*, M. de Mortillet has called attention to the fact that strings of nephrite, which *Callais* much resembles, are found in the mountains of Switzerland and Savoy.

M. de Hochstetter communicates to the Academy of Sciences of Vienna, an interesting paper "On the Nephrite or Jade of New Zealand."†

A new mineral of organic origin has been examined by Professor Arthur H. Church, to which he has given the name of *Tasmanite.* It was first noticed by him in the Tasmanian Court of the International Exhibition of 1862, where it was exhibited by the Dysodile Company, as a "Resiniferous Shale." In the Museum of Practical Geology is another specimen of the same mineral, labelled as "Combustible Shale, River Mersey, north side of Tasmania." Qualitative analysis of Tasmanite showed it to contain, not only a large quantity of carbon and hydrogen, but also a very considerable proportion of sulphur, and it was found that the most careful mechanical treatment of the specimens failed to separate from them completely the mineral impurities. When Tasmanite is heated in the air, it burns readily, with a very smoky flame and offensive odour; submitted to destructive distillation it fuses partially, and yields oily and solid products having a disagreeable smell, recalling that of some specimens of Canadian Petroleum. "One is tempted," writes Mr. Church, "to suggest that the natural rock-oils may in some instances originate in the action of heat upon substances similar to *Tasmanite Shale.*"

The analysis of this mineral gives the following composition:—

	Experiment.	Theory C^{40} H^{62} O^2, S.
Carbon	79·34	79·21
Hydrogen	10·41	10·23
Sulphur	5·32	5·28
Oxygen	4·93	5 28
	100·00	100·00

Mr. Church, regarding the Mineral Retinite as C^{40} H^{64} O^4 compares Tasmanite C^{40} H^{62} O^2 S with it. By this it will seem that the latter differs from the former only by containing H^2 O less, and by the presence of 1 atom of S in lieu of 1 atom of O.‡

Professor Maskelyne and Dr. Viktor von Lang have contributed to the 'Philosophical Magazine' their determinations of the crystalline forms of *Malachite*, of *Gismondine*—a Zoolithic mineral in the form of small square pyramids, which occur on a basaltic lava in the neighbourhood of Rome—and of *Herschelite.* Of the latter mineral, three specimens were examined, one from Aci Reale, one from Aci Castello, and the third from Cyclops, Catania, in Sicily. Another specimen of Herschelite, from Victoria, Australia, is also the subject

* 'Annales de Chimie et de Physique,' January, 1865.
† 'L'Institut,' No. 1645, p. 398.
‡ 'Philosophical Magazine,' December, 1864, p. 465.

of some notice.* A good plate of the crystals accompanies the paper.

M. Felix Pisani presented, in December last, to the Académie des Sciences, some analyses of *Fibro-ferrite* found in the mines of Pallières, in the Département du Gard, France. The composition of this mineral, which is a variety of *Copiapite*, described by Prideaux,† was found to be—*Sulphuric Acid* 29·72, *Oxide of Iron* 33·40, *Lime traces* and water 36·88.

The same chemist and mineralogist also made an additional communication on some new minerals from Cornwall. *Langite* we have already named. *Brochantite* has hitherto been found only in Nassau, Siberia, and in Cumberland. It has now been found in Cornwall. The Cornish Brochantite exists in little crystals of the ordinary form, transparent, and of a vitreous lustre. The composition was found to be—*Sulphuric Acid*, 17·2; *Oxide of Copper*, 68·8; *Oxide of Iron and Lime*, 1·0; Lime, 0·8; and *Water*, 13·2; which gives the ordinary formula of Brochantite, $Cu^3 S^3 + 3$ aq.

Polianite, a variety of Pyrolusite, hitherto unknown in Cornwall, has been found there by M. Pisani. This is, says he, "a new locality to add to those already known of this interesting species, which I regard, with M. Breithaupt, as being the primitive *peroxide of manganese par excellence*."

M. Pisani also notices a porphyroidal granite, in which the mica is replaced by tourmaline, and which belongs to the series of tourmaliniferous granites of M. Senff. The name of *Luxulianite* is proposed for this species, "because it is found in the parish of Luxulian, near Lostwithiel, where it was first recognized by Mr. Richard Talling, to whom also is due the discovery of Langite, Brochantite, Devilline, and Polianite, in Cornwall." ‡

The analyses of several minerals found in the kingdom of Siam was communicated to the Academy of Sciences, at Paris, at the last meeting of the year 1864. These were Gold, Corundum, Oriental Emerald, Iron Ores, some Bitumens, and Clays.

M. Dumas, in the name of M. Marignac, of Geneva, communicated to the Académie des Sciences, on the 16th of January, a memoir upon the "Combinations of Niobium." The author of this memoir arrives at the conclusion that the Hyponiobium of M. Henry Rose is identical with Niobium.

M. Dove has given the Physico-Mathematical Class of the Berlin Academy of Sciences the results of an elaborate examination of the Quartz of Euba, the optical properties of which are compared with those of Carthamine and other substances, showing the phenomena of Dichroism.

M. Schröter has shown that by peculiar treatment, described by

* 'Philosophical Magazine,' vol. xxviii., No. 129, p. 502.

† *See* 'Glossary of Mineralogy,' by H. W. Bristowe, in which work, however, the locality is stated to be Chili only.

‡ 'Les Mondes,' tome vi. p. 585.

him to the Academy of Sciences of Vienna, the Lithioniferous micas will yield Lithium, Rubidium, Cæsium, and Thallium.

M. Hermann has described a new mineral found at Gumeschefsh, in the Ural, which much resembles Wavelite in its mode of occurrence and in composition. To this he has given the name of *Planérite.* Its composition is, as compared with Wavelite, as follows :—

		Wavelite.
Phosphoric Acid	33·94	33·40
Alumina	37.48	35·35
Oxide of Iron	3·52	1·25
Oxide of Copper	3·72	..
Water	20·93	26·80

Brushite.—In a sample of "rock guano" from Avis Island, in the Caribbean Sea, a new mineral has been discovered. Dr. Gideon E. Moore has carefully examined this mineral, and he gives the following as its composition :—

Lime	32·65
Phosphoric Acid	41·50
Water	26·33
	100·48

These figures, he says, agree exactly with the composition of the neutral tri-basic phosphate of lime 2 Ca O, HO, PO_5, with the addition of four equivalents of water of crystallization. The crystalline structure has been examined by Professor J. D. Dana, who thus describes the minerals—"The crystals are slender prisms, not over a third of an inch in length. The prisms are monoclinic, and are often flattened parallel to the clinodiagonal with perfect and pearly clinodiagonal cleavage." This new mineral has been named by its discoverer *Brushite*, after Professor C. J. Brush, of Yale College.*

Emery has been discovered in Chester, Hampden County, Massachusetts. It is spoken of by Dr. Charles J. Jackson as "an inexhaustible bed of the best emery in the world." It appears to have been long mistaken for an iron ore, and indeed used as such. The principal bed of emery is seen at the base of the South Mountain, where it is four feet wide. Its course is N. 20° E.S. 20° W., and its known extent is four miles. Near the summit of the mountain, the bed expands to more than 10 feet in width, and in some places is even 17 feet wide.

The analyses of two varieties—a coarsely crystalline emery of the North Mountain, Cheshire, sp. gr. 3·75 H 9, and the emery from South Hill, sp. gr. 4.02 H 9, are marked respectively 1 and 2—

	(1)	(2)
Alumina	46·51	45·50
Protoxide of Iron	44·00	43·00
Titanic Acid	5·00	11·50
Silica and loss	4·50	
	100·00	100·00

* Communicated to the California Academy of Sciences. 'Silliman's Journal,' January, 1865.

Regarding the iron which can be dissolved out, as accidental, and digesting it in acids, we have—

	(1)	(2)	Naxas best selected.
Alumina . .	60·4	59·05	62·3
Protoxide of Iron .	39·6	40·95	37·7

It is said that practical trials of the Chester emery in the large armouries and machine shops, have proved it to be fully equal in value to the well-known emery of Naxos.*

Petroleum in California.—Professor Silliman recently visited a newly-discovered petroleum region, which he thus describes in his Report:—"Ten miles north of Buenaventura, there is a mountain ridge 2,000 feet in height, extending for 13 miles from E. to W., which consists in part of bituminous shales, supposed to be either of the Cretaceous or Tertiary period. The dip of the layer is 70° to 80° to the north. From these shales, mineral oil comes out in many places, and at some points very abundantly. One of these wells is 30 feet in diameter, and is full of tar-like oil, boiling with the escape of marsh gas. There is also an area of asphaltum three-fourths of a mile long by half-a-mile wide, exuding tar and rock oil at numerous points, besides several oil springs, the places of discharge in all exceeding twenty. The range of bituminous shales occurring at intervals for a hundred and fifty miles, and also as far north as Glenroy, in Santa Clara County, or about 80 miles from San Francisco.†

Some interesting analyses of several varieties of lead ores from the mines of Pontgibaut (Puy-de-Dôme) have been made by M. Charles Mène and M. L. Courrat, of Lyons, the results of which have been communicated to the Académie des Sciences of Paris. The minerals examined were the *Sulphate of Lead* (Anglesite), *Arsenio phosphate of Chloride of Lead*, and the crystallized *Carbonate of Lead.* For the result obtained we must refer our readers to the ordinary sources through which the communications of the Academy are given to the public.‡

Metallurgy.

During the first quarter of 1865 there has been little of novelty to record. The extension of the application of machinery to puddling has been steadily going on. Mr. Menelaus, the manager of the iron works at Dowlais, appears to have been very successful in the experiments which he has made; and as soon as a new set of furnaces,—now in course of construction,—are in a fit state for use, he invites the iron-masters and managers of works to some public experiments to be then made at Dowlais.

We learn that the preliminaries for a patent have been taken by Mr. John Arthur Phillips, for a process of great simplicity, by means

* 'Silliman's Journal,' vol. xxxix. p. 87.
† 'Silliman's Journal,' vol. xxxix. p. 101.
‡ 'Les Mondes,' 6 liv. 9 February, 1865.

of which coppery lead can be rendered equal in quality, for white lead manufacture, to W. B. lead.

The French Government has published some very complete returns of the manufacture of iron in that country. These show a rapid improvement in, and a great extension of, the manufacture of iron in France.

A large volume has been published at Turin, by the Italian Government, 'On the Manufacture of Iron in Italy.' Nothing can show more strikingly than this work does, the advantages which must arise from the liberal government under which that country is now placed. The amount of information given in this book, which has been compiled and printed regardless of cost, is very great; and we particularly recommend it to the attention of all who are interested in this special industry.

The Queen of Spain is said to have determined on having a Mineralogical and Geological Survey made of that country, with an especial view to the extension of its mines and metallurgical works.

It is pleasant to hear that a similar survey is to be carried forward with all dispatch in Portugal.

Dr. Lermer, in a paper entitled "On the Chemical Resistance of Lead and its Alloys with Tin to the Vapour of Water," desires to show, that whereas pure lead is actively attacked by water vapour, the addition of tin prevents this action. With equal parts of lead and tin, the action is only 1-10th of that which takes place with pure lead, and an alloy containing 37 per cent. of lead is scarcely attacked at all.*

The effects of Wolfram upon Ordnance Castings, form the subject of an important paper, by M. Le Quen. From this it would appear that great additional toughness is communicated to iron by an admixture of wolfram.†

The cementation of iron is still a subject of eager discussion between the French manufacturers of steel and the chemists. M. Julian has lately communicated a note on this subject to the Academy. The results of experiments with graphite are said to be in complete opposition to the assertions of M. Caron, on the one side, and those of M. Fremy, on the other. We are content for the present to leave this subject without further notice, as, without doubt, the whole question will be carefully examined by other chemists.

A paper of considerable interest, on "Les Grandes Usines de France," appears in 'Les Mondes.' It notices especially the Blast furnaces, Forges and Steel works of Petin, Gaudet and Company, at Vierzon, Givors, Toga, Rive-de-Gier, St. Chamond, and Assailly; another section describes the Mines and Smelting-works of the Veille Montagne Company, Moresnet, Angleur, Bray, Tilff, Valentin-Coq, and other places. The Warm Baths of Vichy have also some notice.‡

* 'Chemisches Central-blatt,' No. 4, 1865.

† 'Annales de Chimie et de Physique,' January, 1865.

‡ 'Les Mondes,' tome vi. p. 713.

IX. PHYSICS.

Light.—Light and astronomy are so nearly allied, that it is frequently a matter of difficulty to know how to apportion the subjects treated of in these Chronicles. This difficulty is more especially felt at the present time, when spectrum-analysis—a subject which has been hitherto hovering between chemistry and optics—has suddenly shot off to the sun and fixed stars, and is commencing more distant flights to the nebulæ. We have divided the subjects in this branch as well as the circumstances will admit; but the natural tendency which there has been of late years to the mutual interpenetration of all the sciences, will necessarily cause a great deal of chemistry and astronomy to come into optics, as well as astronomy and optics into chemistry. With this explanation, we will proceed to chronicle a most important service which optical science has done for her great sister astronomy—a service the more remarkable, inasmuch as astronomy, whilst she was really unable to solve the difficult question, fancied that the whole subject was a very straightforward one, and had fallen into an error which it will take perhaps the remainder of this century to eradicate from astronomical text-books. We refer to the constitution of the nebulæ. These bodies are generally divided into resolvable and irresolvable, the former being split up under more or less powerful telescopic means into bright points, which have been always considered stars, whilst the irresolvable ones have been generally regarded as being similar clusters of stars, too far off, however, to be resolved into discrete points by our present optical means. As the aperture and defining power of telescopes increased, nebulæ of the latter class have one by one been transferred to the former, until the opinion has gradually prevailed, that all nebulæ would ultimately prove to be resolvable. Although serious doubts as to the generality of such a law have been entertained by many eminent astronomers, the question would have long remained unsolved had not the services of spectrum-analysis been called into requisition.

In a paper recently presented to the Royal Society, Mr. William Huggins gave the results of the application of prismatic analysis to some of the objects in the heavens known as nebulæ. Eight of the nebulæ examined gave a spectrum indicating gaseity, and of these six belong to the class of small and comparatively bright objects, which it is convenient to distinguish still by the name of planetary. These nebulæ present little indication of probable resolvability, even with the greatest optical power which has yet been brought to bear upon them. The other two nebulæ, which gave a spectrum indicative of matter in the gaseous form, were the annular nebula in Lyra and the Dumb-bell nebula. The results of the examination of these nebulæ with telescopes of great power must probably be regarded as in favour of their consisting of clustering stars; it was therefore of importance to determine by the observation of other objects, whether any nebulæ which have been certainly resolved give a spectrum which shows the source of light to be glowing gas. With this purpose in

view, the light of two easily-resolved clusters was submitted to spectrum-analysis, but both gave a continuous spectrum.

Mr. Huggins then examined the Great Nebula in the Sword-handle of Orion.* The results of telescopic observation on this nebula seem to show, that it is suitable for observation as a crucial test of the correctness of the usually received opinion—that the resolution of a nebula into bright stellar points, is a certain and trustworthy indication that the nebula consists of discrete stars, after the order of those which are bright to us. Would the brighter portions of the nebula, adjacent to the trapezium, which have been resolved into stars, present the same spectrum as the fainter and outlying portions? In the brighter parts would the existence of closely-aggregated stars be revealed to us by a continuous spectrum, in addition to that of the true gaseous matter?

The telescope and spectrum apparatus employed were those of which a description has already been given in our Chronicles of Astronomy. When turned towards the brightest parts of the nebula near the trapezium, the light was resolved by the prisms into three bright lines in all respects similar to those of the gaseous nebulæ. These three lines appeared (when the slit of the apparatus was made narrow) very sharply defined, and free from nebulosity; the intervals between the lines were quite dark. When either of the four bright stars β, γ, δ, Trapezii, was brought upon the slit, a continuous spectrum of considerable brightness, and nearly linear (the cylindrical lens of the apparatus having been removed), was seen, together with the bright lines of the nebula, which were of considerable length, corresponding to the length of the opening of the slit. The fifth star γ', and the sixth α', are seen in the telescope, but the spectra of these are too faint for observation.

The positions in the spectra of α, β, γ, δ, Trapezii, which correspond to the positions in the spectrum of the three bright lines of the nebula, were carefully examined; but in no one of them were dark lines of absorption detected.

The part of the continuous spectra of the stars α, β, γ, near the position in the spectrum of the brightest of the bright lines of the nebula, appeared on a simultaneous comparison to be more brilliant than the line of the nebula; but in the case of γ, the difference in brightness was not great. The corresponding part of δ was perhaps fainter. In consequence of this small difference of brilliancy, the bright lines of the adjacent nebula appeared to cross the continuous spectra of γ and δ Trapezii.

Other portions of the nebula were then brought successively upon the slit; but throughout the whole of those portions of the nebula which are sufficiently bright for this method of observation the spectrum remained unchanged, and consisted of the three bright lines only. The whole of this great nebula emits light, which is therefore identical in its characters; the light from one part differs from the light of another in intensity alone. The clustering stars, of which, according to

* 'Proceedings of the Royal Society,' vol. xiv. p. 39.

Lord Rosse and Professor Bond, the brighter portions of this nebula consist, cannot be supposed to be invisible in the spectrum apparatus because of their faintness—an opinion which is probably correct of the minute and widely-separated stars seen in the Dumb-bell nebula. The evidence afforded by the largest telescopes appears to be, that the brighter parts of the nebula in Orion consist of a "mass of stars;" the whole, or the greater part of the light from this part of the nebula, must therefore be regarded as the united radiation of these numerous stellar points. Now it is this light which, when analyzed by the prism, reveals to us its gaseous source, and the bright lines indicative of gaseity are free from any trace of a continuous spectrum, such as that exhibited by all the brighter stars which have been examined.

The conclusion is obvious, that the detection in a nebula of minute closely associated points of light, which has hitherto been considered as a certain indication of stellar constitution, can no longer be accepted as a trustworthy proof that the object consists of true stars. These luminous points, in some nebulæ at least, must be regarded as themselves gaseous bodies, denser portions probably of the great nebulous mass, since they exhibit a constitution which is identical with the fainter and outlying parts which have not been resolved. These nebulæ are shown by the prism to be enormous gaseous systems; and the conjecture appears probable that their apparent permanence of general form is maintained by the continual motions of these denser portions which the telescope reveals as lucid points.

The opinions which have been entertained of the enormous distances of the nebulæ, since these have been founded upon the supposed extent of remoteness at which stars of considerable brightness would cease to be separately visible in our telescope, must now be given up, in reference at least to those of the nebulæ the matter of which has been established to be gaseous.

It is much to be desired that *proper motion* should be sought for in those of the nebulæ which are suitable for this purpose; indications of parallax might possibly be detected in some, if any nebulæ could be found that would admit of this observation. If this view of the greater nearness to us of the gaseous nebulæ be accepted, the magnitudes of the separate luminous masses which the telescope reveals as minute points, and the actual intervals existing between them, would be far less enormous than we should have to suppose them to be on the ordinary hypothesis. It is worthy of consideration, that all the nebulæ which present a gaseous spectrum exhibit the *same three bright lines;* in one case only, 18 H. IV., was a fourth line seen. If we suppose the gaseous substance of these objects to represent the "nebulous fluid" out of which, according to the hypothesis of Sir W. Herschel, stars are to be elaborated by subsidence and condensation, we should expect a gaseous spectrum in which the groups of bright lines were as numerous as the dark lines due to absorption which are found in the spectra of the stars. Moreover, if the improbable supposition be entertained, that the three bright lines indicate matter in its most elementary forms, still we should expect to find in some of the nebulæ, or in some parts of them, a more advanced state towards

the formation of a number of separate bodies, such as exist in our sun and in the stars; and such an advance in the process of formation into stars would have been indicated by a more complex spectrum.

It is a point of some interest at present to know whether certain lines in the solar spectrum are due to the sun or to the earth—that is, whether they are due to the absorption of rays by the solar or the terrestrial atmosphere. Knowing this, we should be enabled to ascertain whether special bands which are seen in the spectra of the planets, Jupiter especially, were due to their atmospheres. Father Secchi* has lately communicated the results of some very accurate measurements which he has made upon these bands with the object of learning to what they were due. The solar rays and that of sodium served as the starting-point for the measurements. The atmospheric rays were determined by observing the air near the horizon. The moon was also sometimes made use of when it was a little above the horizon. Great care was taken each time to fix the micrometric slit upon one of the strongest atmospheric rays, to see if they coincided or not with those of Jupiter. In the interval between the observations the instrument was left untouched, although it was subsequently observed that this precaution was superfluous. The various bands were not equally easy to measure, for some are more diffused on one side than the other; and that of the dark red is difficult, especially if the air is at all impure. The results show that the bands of Jupiter do not agree at all with those of our atmosphere, whilst some are quite wanting. The general results do not disprove the existence of solar rays in the planet, but show that its atmosphere has a strong absorbing power, and a different one from ours.

At the meeting of the Manchester Literary and Philosophical Society, on January 10, Dr. Roscoe exhibited some very interesting photographs of the fixed lines in the solar spectrum made by Mr. Rutherford, of New York. These photographs exhibit groups of thousands of lines, extending from near the line *b* in the green, to beyond H in the violet, and serve as a most valuable confirmation of the accuracy of Kirchhoff's maps. Each line in these maps can be easily and distinctly traced in the photograph, whilst many bands drawn as single ones by Kirchhoff are seen in the magnified photograph to consist of bundles of fine lines. These photographs were prepared with three 60° bisulphide of carbon prisms.

A new spectroscope, in which the great desideratum of direct vision is obtained, has lately been made by the well-known optician, Browning, from designs furnished him by A. Herschel, Esq. The principle is as follows:—What is called a 3 to 1 right-angled prism, in which the hypotenuse is three times as long as the base, is placed in the path of a ray of light in such a manner that the ray falling at an angle of 45° on the shortest side of the prism, is refracted, then twice reflected totally, when it emerges at an angle of 45° from the prism, but in the same direction as when it entered. The light is *dispersed* both at its entrance and at its emergence; but owing to the *two* reflec-

* 'Phil. Mag.,' vol. xxviii. p 486.

tions which it has suffered, the dispersion, at its exit, is added to the dispersion at its entrance instead of being subtracted from it, as would have been the case had only one reflection taken place. The instruments are made with two such prisms connected together by their like ends; the combination producing a direct vision spectroscope, of which the dispersive power is four times greater than that of any single surface of the prisms. With a magnifying power of 5 only, Fraünhofer's line D is appreciably separated, whilst the other dark lines are seen with much distinctness and in great numbers. The slit is fixed on a slider, by means of which arrangement any part of the spectrum may be brought into the field of view.

It is to be hoped that some information will soon be obtained respecting the composition of meteors from the colours which they assume. Data for such theoretical discussions are being gradually accumulated. Mr. Schmidt has recently communicated to the Belgian Academy some observations made at Athens on the colours of shooting stars; he finds that red and green coloured meteors are most often seen in summer. The author has noted the colour of 5,671 meteors; 4,300 of these were white, 905 yellow, 320 red, and 146 green.

With one useful application of light to the requirements of everyday life we will conclude our chronicles of this branch of science. In some parts of Paris some very successful attempts have been made to render the names of the streets as visible at night as in the day time. In the neighbourhood of the Hôtel de Ville, the names are now lighted up in the following manner:—the frame in which the letters are set is made in the form of a rectangular trough, the upper and lower portions being pierced with holes to allow of proper ventilation, and within this is a gas pipe with a number of small jets, according to the length of the tablet; in front of these jets are arranged the transparent letters which are thus brightly illuminated. The upper part of the box or trough opens to allow of lighting and repairs, and is closed by a counterpoise concealed in the stone work of the walls.

Heat.—Professor Tyndall has communicated to the Royal Society the results of his important researches on the invisible heat radiation of the electric light. The distribution of heat in the spectrum of the electric light was examined by means of a linear thermo-electric pile. The electric spectrum was formed by lenses and prisms of pure rock-salt, its width being equal to the length of the row of elements forming the pile. The latter standing at right angles to the length of the spectrum was caused to pass through its various colours in succession, and to search the spaces beyond the region of colour in both directions. As in the case of the solar spectrum the heat was found to augment from the violet to the red, while the maximum heating effect was observed beyond the red. The augmentation of temperature beyond the red in the case of the electric light is sudden and enormous, being much greater than that obtained by Professor Müller for the solar spectrum. Aqueous vapour acts powerfully upon the invisible rays, and doubtless the action of this substance in our atmosphere has modified the intensity of the rays beyond the red. In the experiments

now to be referred to, the rays from the electric light were converged by a small concave glass mirror silvered at the back. It was brought so near the electric light as to cast an image of the coal points five or six inches in advance of the light. A solution of iodine in bisulphide of carbon contained in a rock-salt cell was then placed in front of the lamp; the whole of the luminous rays were thereby cut off, the dark heat rays only coming to a focus.

In this focus of intense heat, in which nothing whatever is visible to the sight, what will take place if a solid body is introduced? Will the body become red or white hot; that is to say, will the long vibrations of the heat rays be exalted in refrangibility and vibrate in a quicker period? We know that rays can be lowered in refrangibility, but the possibility of rays of low refrangibility being raised higher has been denied by some physicists on theoretical grounds. The experiments of Professor Tyndall have conclusively settled the question, and proved that rays can be transmitted upwards, as well as downwards.

With an eight-inch mirror behind the electric light, the opaque solution of iodine in front, and the focus of invisible rays about six inches distant from the electric light, the following effects have been obtained:—Wood painted black, when brought into the dark focus, emits copious volumes of smoke, and is soon kindled at the two spots on which the images of the two coal points fall. A piece of brown paper placed near the focus soon shows a burning surface which spreads over a considerable space, the paper finally bursting into flame. The end of a cigar placed at the dark focus is instantly ignited. A piece of charcoal suspended in a receiver of oxygen is ignited in the dark focus and caused to burn brilliantly. A mixture of oxygen and hydrogen is exploded in the dark focus by the ignition of its envelope. Magnesium wire presented suitably to the focus, burns with its intensely luminous flame. In all these cases the effect was due in part to chemical action; this, however, may be excluded. For instance, platinized platinum in thin leaf may be rendered white hot, and on it is depicted an incandescent image of the coal points. When the points are drawn apart or caused to approach each other, their incandescent images conform to their motion. Professor Tyndall proposes that the assemblage of phenomena here described, and others to be referred to in his completed memoirs, should be expressed by the term "calorescence." This word involves no hypothesis, and it harmonizes well with the term fluorescence, now universally employed with reference to the more refrangible end of the spectrum.

The subject of dissociation of the elements of compound gases at high temperature is being energetically worked out by H. Ste. Claire Deville.* He has previously shown that both water and carbonic acid possess the apparently paradoxical property of partially resolving themselves into their elements when heated to a much lower point than that attained by the combination of the elements of which they are composed. The great difficulty in experiments of this kind is to prevent the decomposition from being immediately followed by a re-

* 'Chemical News,' vol. x. p. 285, and vol. xi. p. 2–90.

combination of the separated elements; this can only be effected by causing these elements to come in contact with a relatively very cold atmosphere. By a modification of his apparatus, M. Deville has succeeded in effecting the dissociation of carbonic oxide, sulphurous, hydrochloric, and carbonic acids, and ammonia. He passes through a furnace a porcelain tube, with corks at each end, through which is introduced a small brass tube. In the space between the porcelain and the brass tube, a current of the gas under experiment is allowed to flow by means of glass tubes passing through the corks. A rapid current of water is constantly passing through the brass tube, which is thereby kept cold, whilst the porcelain tube can be raised to a white heat. The apparatus being thus arranged, a current of pure dry carbonic oxide is passed through the porcelain tube, and as it issues out it is conducted into baryta water, by means of which the presence of carbonic acid may be shown. As soon as the porcelain tube attains a red heat, the carbonic oxide is decomposed into oxygen (which burns a further quantity of carbonic oxide into carbonic acid), and carbon, which attaches itself in the form of lamp-black to the brass tube traversing the porcelain tube.

We have thus in a very small space a greatly heated cylindrical porcelain surface, and a very cold brass surface. The molecules of carbonic oxide heated in the porcelain tube, after having been partially decomposed into oxygen and carbon, encounter the cold side of the brass tube, when the particles of carbon mechanically attach themselves to it. Here being cooled by the water circulating in the metal tube, the carbon escapes the action of the oxygen or carbonic acid. The brass tube is, in fact, found to be blackened by the carbon when the apparatus is carefully taken to pieces, and its quantity is in proportion to the quantity of carbonic acid contained in the escaping gas. In the experiment with sulphurous acid, the inner metallic tube which carries the stream of cold water was silvered on its external surface. After the current of sulphurous acid had continued for some hours, the silver surface was found to be blackened or sulphuretted, and at the same time covered with a layer of anhydrous sulphuric acid, showing that sulphurous acid had been dissociated or completely decomposed into sulphur, which was deposited on to the silver and oxygen which combined with the excess of the acid to form sulphuric acid. Until now sulphurous acid has been considered completely undecomposable by heat. In the experiment with hydrochloric acid, the author amalgamated the silvered surface of the cold tube with a very small amount of mercury, and so obtained a very brilliant surface. After pure hydrochloric acid gas had passed for some hours, this surface was found covered with chloride, and by a peculiar arrangement M. Deville was able to collect some hydrogen. Carbonic acid and ammonia were decomposed with the induction spark.

A very ingenious maximum thermometer has been described by Mr. Twining.* It is a spirit thermometer, having about one-third of the way up the tube a small bulbous enlargement, in which is lodged

* 'Chemical News,' vol. xi. p. 29.

a globule of mercury, which serves as an indicator. As long as the spirit rises, this globule remains stationary; but as soon as the spirit descends, the mercury sinks likewise, lengthening into a small cylinder, about 1-10th or 1-12th of an inch long, which cuts in two the column of alcohol. It is evident that on adding to the degrees marked by the extremity of the spirit-column, those shown by the inferior extremity of the indicator on the lower scale, we ascertained at once the maximum of heat to which the apparatus has been exposed. Upon warming the bulb of the instrument with the hand till the mercury reaches the enlargement, and then placing the instrument flat while the spirit cools, the thermometer is ready for another observation. The advantages of an instrument of this kind are—1, it is available for taking observations where only an upright thermometer can be used; 2, it is not affected by travelling; and 3, it is very easy to make.

The use of petroleum as steam fuel in place of coal, is attracting considerable attention. Mr. C. J. Richardson is conducting experiments at Woolwich Dockyard, with the view to test the capability of petroleum to supersede coal and other fuel on board ship. Dr. Paul has published some calculations, in which he attempts to prove that the proposed application of it is based upon erroneous impressions respecting the composition and character of petroleum as compared with coal. He starts with the statement that the oil can be so utilized that one ton is equal for steam purposes to five tons of coal. Now, the specific gravity of coal being about 1·44, whilst that of petroleum is from 0·80 to 0·85, the weight of a cubic foot of these materials would be respectively—coal 90lbs., and petroleum 50lbs to 53lbs. But since petroleum, being liquid, lies in a more compact manner than coal, in estimating the spaces occupied by these materials an allowance of one-third should be made for the interstices or empty spaces between the lumps of coal; so that the spaces occupied by equal weights of coal and petroleum are about as 1 is to 1·2 or 1·4. Then the relative heating-power of equal weights of coal and petroleum, depending upon their respective chemical composition, are in the following ratio:—Calorific power—coal, 1·02, petroleum, 1·50; and the spaces occupied by quantities of petroleum and of coal would be in the ratio of 1 to 1·16; a difference in favour of petroleum too small to admit of any advantage being gained in regard to stowage. The question of price, moreover, must not be left out in such discussions. Dr. Paul argues that, since the price of petroleum varies from 15*l.* to 20*l.* per ton, whilst that of coal used for steam-vessels varies from under 1*l.* to 3*l.* 10*s.*, the cost of equal quantities of heat produced from these materials would be, under the most favourable circumstances, as in the ratio of 15*l.* to 4*l.* In addition to this, the highly inflammable nature of petroleum must be considered. Its storage on board a ship would require the use of air-tight vessels, and even then there might be considerable risk of the production of explosive mixtures of the petroleum vapour and air. What, asks Dr. Paul, would be the condition of a vessel of war provided with petroleum as fuel if

a shot penetrated the vessel containing the petroleum, and allowed it to escape in proximity to the boiler fires?

In answer to these objections of Dr. Paul, Mr. Richardson, the patentee, asserts that the relative heating-powers of petroleum and coal, as depending upon their chemical composition, is not the question; the ability of each to create steam is the real matter to be considered. Petroleum, as steam fuel, can be very nearly fully utilized: it produces no ash, submits to mechanical management, and makes little or no smoke; does not require any strong draught or current of air like coal, which will not burn without it, the consequence being that a very considerable portion of the fuel is lost, as waste heat, in the chimney. In careful experiments by Mr. Wye Williams, to ascertain the best form of boiler to obtain the greatest amount of heat from coal, he gives the temperature of the waste heat in the first experiment as 1060°; in the second, 760°; and in the third, 635°. If these are the temperatures, with a consumption of only three-and-a-half cwt. of coal in each experiment, what would be the temperature of the waste heat in the chimney of a furnace burning from twenty to thirty tons of coals per day? We know the current is so strong that it often carries up small coal and cinders along with it; that the heated gases often take fire by a spark from the furnace, and burn at the top of the funnel with a fierceness almost equalling the flame from a blast furnace. Is this flame or waste heat employed in creating steam? And how much of the coal is utilized? In practice, Mr. Richardson says, the ratio of the heating-power of petroleum and coal is about 1·4 to 0·4. The patented grate, which burns petroleum through a porous matter, proves that one ton of petroleum does as much work as five tons of coal. If four tons out of five are saved for freight space, the price of the latter being 7*l.* per ton, the profit on every ton of petroleum would be 14*l.* 15*s.*—the coal at 15*s.*, the petroleum at 17*l.* per ton. But a ship-owner might not select the American crude oil at 17*l.*; he could take the Flintshire coal oil, which is quite as good for his purpose, and costs only about 10*l.* per ton. The average price of coal on a long voyage would be low at 2*l.* per ton. Taking the prices and the freight at the reduced sum of 5*l.* per ton in a ship requiring 500 tons of coal, and using instead 100 tons of petroleum, the profit by the exchange would be 2,000*l.* Respecting the highly dangerous inflammable nature of petroleum, Mr. Richardson considers it to be greatly exaggerated. If the oil were contained in cast-iron cases, securely closed, no vapour could escape; or if the small amount of spirit which produces the inflammable vapour was first extracted, the residue, the burning oil and heavy petroleum, would be no more dangerous than so much lard or spermaceti.

Lenoir's gas engine, which has been at work in Paris for some time past, may now be seen daily in use in London. In appearance, the Lenoir engine is very much like a horizontal steam-engine, having a cylinder, piston, crank, shaft, and fly-wheel. The cylinder has the necessary slide arrangements for the admission of coal gas, and atmospheric air in due proportions, which, at the proper moment, are

ignited by the electric spark. Contact is made and broken by the rotary action of the crank shaft, and the explosive force, consequent on the ignition, gives motion to the piston on each side alternately. The cylinder has a water jacket surrounding it, through which a stream of cold water is kept gradually flowing, to absorb any excess of heat. The mixture exploded is about eleven volumes of air to one of gas. The consumption of gas is as near as may be seventy feet per horse-power per hour of actual work, giving a cost, with gas at 4*s.* 6*d.* per thousand feet, of about 4*d.* Besides this cheapness, the engine is recommended by its simplicity, cleanliness, and safety. When set in motion, the machine requires no attention, and the batteries only want charging once a week.

Electricity.—A very ingenious battery, which is said to be both constant and cheap, has been proposed by Mr. Arthur Reynolds, B.Sc. The exciting liquid being a solution of perchloride of iron, and the metal to be attached metallic iron, the copper plate being replaced by carbon. The action of the battery, according to the inventor, would be quite constant, as the exciting liquid would always remain in the same condition. The iron dissolving by reducing the solution to protochloride, which being oxydized by the air, would be deposited so that the solution would always remain of the same strength. This would be as cheap, or cheaper, than any other form of battery, and perpetually constant. The purpose to which it is proposed to employ the battery, is to the manufacture of magnesium from sea-water. The sea-water should be evaporated with a little chloride of calcium, and after the main bulk of common salt and sulphate of lime had crystallized out, the solution should be evaporated to dryness. The dry mass melted and decomposed by the above-described battery.

Professor Bunsen has described some powerful thermo-electric piles, which are likely to prove of great value. Hitherto, bismuth has occupied the highest, and an alloy of two parts of antimony, with one part tin, the lowest place in the thermo-electric series. It has now been shown that pyrolusite stands above bismuth in the series, and that copper pyrites occupies a far higher place than even pyrolusite. When copper pyrites is combined with the above alloy, so as to form a thermo-electric pair, or, better still—in order to be able to employ greater differences of temperature—when copper pyrites is combined with copper, far stronger currents are obtained than, under the same circumstances, are yielded by any of the thermo-electric piles hitherto in general use. When heated to above the temperature of melted tin, the other end being cooled in water of 60° C., one single element exhibited a ten times greater action than a bismuth and antimony element of equally effective resistance when heated from 0° to 100° C. Ten of the above described pairs formed into a battery suffice to give all the actions of a Daniel's element, containing an effective copper surface fourteen square centimetres in area. Copper pyrites, in its natural state, melts easily at a strongly glowing heat without sensible decomposition, and it may then be cast into any mould whatever. It is a remarkable fact, however, that this sub-

stance thereby suffers a change, in consequence of which, it sinks far below bismuth in the thermo-electric series. Consequently it is only the mineral in its natural state, which can be employed for such thermo-electric piles; in that state, however, it can be easily worked into any required form.

It is stated by Mr. Richer, that a disc of sulphur makes an excellent machine for frictional electricity. He melts it and cools it rapidly three or four times, and then moulds it into a disc, which may be two or three centimetres thick, and a metre in diameter. Unless sulphur possesses some very remarkable properties in this respect, it is not likely that this brittle material will replace ebonite, a substance which appears to have been sent for the especial gratification of all who are in any way connected with electrical experiments. In reference to this paper, M. Deville has recalled the fact mentioned by M. Dietzenbacher some time ago, namely, that the addition of a little iodine or bromine gave great plasticity to sulphur.

The fable of Mahomet's coffin, said to be suspended in mid-air by means of powerful magnets, has attracted some small amount of serious attention on the Continent, and M. Plateau, of Ghent, has been at the pains of calculating whether it would be possible by any arrangement of magnets to suspend a magnetized needle in the air in a state of stable equilibrium without any point of support; and he announces, with regret, "Hélas," that he finds it utterly impossible.

The sulphurous waters of Bagnères de Luchon, are said, by M. Lambron, to show, when received in a glass or bath, an excess of positive electricity on the upper surface, and of negative electricity on the lower surface, and when a person is in a bath he completes a circuit, and has a stream of electricity running through him. Moreover, when a patient gets a *douche* of the water, the part of the body soused is negatively electrified, the other parts of the body being positive. It is supposed that these currents must produce a certain action on the animal economy, and it is noticed that the waters when transported from their source do not lose their electrical properties.

The adaptation of electricity to the production of motive force is attracting considerable attention in France just now. MM. Bellet and Rouve are exhibiting at Versailles a small locomotive driven by electricity. This certainly merits some attention, since the inventors do not seem to claim any extraordinary powers for their machine. They only propose it for carrying light weights, such as letters by an underground railway. The driving-wheel of the engine is made of copper, through which at equidistant intervals pass a series of horse-shoe electro-magnets—twenty in the whole circumference. The current is made to pass successively through these magnets, contact being made and broken by means of two discs at the axis of the wheel, the iron rail attracting these magnets causes the rotation of the wheel, and in the absence of great weight the vehicle progresses at an extraordinary speed; locomotives on this plan being asserted to be able to travel with ease on existing railways at a rapidity of 120 miles an hour. The batteries are placed at the termini to save the weight and the carriage, and the current is conveyed by insulated wires running between the

rails and over a roller in the locomotive. With respect to this plan an American paper enters into some curious calculations as to what such an engine would do in the way of jumping. The velocity is 181·825 feet per second; the square of $\frac{1}{8}$th of which is 516·55, which is the height to which a body moving upward at this speed would rise. Were this electrical horse to make a turn upwards at an angle of 45°, he would describe a parabola 258 feet high and 1,032 feet long.

In connection with this subject we may mention an electric brake which has been recently under experiment on the Strasburg Railway. A system of brakes attached to any number of carriages in a train is brought into operation by interrupting an electric current by means of a little apparatus attached to the tender, and thus under the control of the driver. When contact is made, and the current is established again, the brakes cease to act. Connected with this is an arrangement by which the guard and even the passengers can communicatc with the engine-driver. The experiments made showed that all the contrivances were perfectly effective, trains going at great speed being brought to rest in a distance of 250 to 300 metres, instead of from 1,200 to 1,500 as by the usual system of brakes.

With an improved method of pointing pins and needles, we will conclude our chronicles of physics for this quarter. It is known that if the two electrodes of copper, iron, or steel, are set vertically in acidulated water, and reaching nearly to eaeh other, the positive very quickly becomes pointed. The experiment can of course be made by making the positive pole of a number of wires, and carefully regulating the negative pole. Two or three Bunsen's cells only are required to do the work. Considering the diseases which arise from pointing pins and needles in the usual way, this method, which is a discovery of M. Cauderay, certainly deserves attention, although some supplementary polishing would seem to be inevitably required.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

(*Including Micro-Zoology and the Proceedings of the Zoological Society.*)

At the annual meeting of the French Academy, on the 6th February, the awards were made to the successful competitors for prizes, and new prizes were proposed on various subjects. The prize for Experimental Physiology was carried off by M. G. Balbiani, who has already distinguished himself by his researches and discoveries in regard to the sexuality of the Infusoria. His present work has been devoted to the constitution of the germ of the animal ovum before fecundation. He has shown that, contrary to the usually-received notions, the germinating element is formed round a different vesicle to that known as the germinal vesicle, or the vesicle of Purkinje. MM. Siebold, Wittich, and Victor Carus, had formerly observed in a spider's egg, a particular corpuscle distinct from this vesicle; but it had occurred to no one that this observation was of fundamental importance.

The general demonstration of a focus distinct from the germinal vesicle round which the first materials of the germ group themselves, extensively modifies our knowledge of the manner in which the rudiments of an organism is formed. It opens out, therefore, a way to studies which will enable us to penetrate nearer the origin of living beings.

Another prize has also been awarded to M. Gerbe, for his discovery of the reproduction of Kolpods. In his researches on the embryology of marine crustacea he observed that the kolpods connected themselves by pairs, after the manner of the conjugation of confervæ. Following this conjunction, unique in the animal kingdom as far as is known at present, he has shown that in the common matrix formed by the fusion of the two individuals of each couple, the reproductive organ of each is divided into two, and four reproductive ovules are thus formed in the matrix, which then dies. These oviform germs are soon disengaged, showing living and moving kolpods, in precisely the same manner as does the newly-born conferva. It will be seen that M. Gerbe's observations supply us with an analogy between the generation of animals and that of plants.

Prizes of 3,000 francs are offered for the following subjects, the essays to be sent in by November 1st of the present year:—1st. An inquiry whether in those animals of which the eggs are impregnated after they are laid, hybrid products can result from a mixture of animals of species not nearly allied; also, whether the vitality of these abnormal productions so obtained is in relation with the degree of heterogeneity of their parents; by which experiments it is hoped that interesting results may be obtained on the subject of the *fecundity of hybrids*, and of the degree of fixity of their zoological characters. 2nd. A comparative study of the nervous centres of the encephalon of fishes, in order to demonstrate rigorously the analogies and differences which exist between their functions in fishes and the higher mammalia, and to throw light on the zoological affinities between the different species of fishes themselves, and furnish fresh data for their classification. 3rd. An osteographical work which shall most contribute to the advancement of French Palæontology, either by making better known the anatomical characters of one or more types of vertebrata, and in thus furnishing important elements for the study of tertiary faunas; or treating in an exhaustive manner of the fossils which belong to one of the least known classes of this great branch of the animal kingdom.

While referring to prizes, it may be mentioned that the Royal Society of Edinburgh offer a Neill prize, consisting of a gold medal and a sum of money for a paper of distinguished merit on a subject of natural history by a Scottish naturalist, which shall have been presented to the Society during the three years preceding May 1st, 1865; or, failing presentation of a paper sufficiently meritorious, it will be awarded for a work or publication by some distinguished Scottish naturalist, on some branch of natural history, bearing date within five years of the time of award (*viz.* the commencement of the session 1865–6).

Dr. Humphry, in a communication to the Cambridge Philosophical Society, defends the vertebral theory of the skull on the ground of the constancy of the law of uniformity of plan with variety of detail. It is by all anatomists admitted that the skull is segmentally constructed, and most anatomists are agreed as to the number of the segments. He argues that they should therefore be described by the same name as those of which they are a continuation, since the segmental construction of the skull—the relation of its components to surrounding parts, and so many fundamental resemblances in development, unite to prove that one as well as the other consists of vertebræ modified to meet the requirements of the parts in which they are found. Although, therefore, Professor Huxley has expressed an opinion that the vertebral hypothesis of the skull has been abolished by the recent discoveries in development,* Dr. Humphry affirms, that the greater number of those anatomists to whose observations we are indebted for most of our knowledge of the development of the skull and of the trunk, are agreed that the differences between the mode of formation of the segments in the two form no real argument against the vertebral character of either.

Professor Peters, in a paper before the Academy of Sciences at Berlin, adds another to the exceptional cases of mammals having more or less than seven cervical vertebræ. The only exceptions previously known were the genera Bradypus (Sloth) and Manatus (Manatee). In the former the number varies from eight to ten, and in the latter it is usually six. The example now added by Peters is a species of two-toed sloth, described by him in 1858 under the name of *Cholœpus Hofmanni*, of which he has received several skeletons, all of which present only six cervical vertebræ.

It is remarked by the natives and old settlers of New Zealand, that many of the native birds are getting scarcer, and a few varieties have all but disappeared. A collector remarks, that of birds which were formerly common he has failed in getting even a single specimen. Early navigators and visitors to New Zealand speak with raptures of the melody of the birds in the woods at early morn. But that the birds are now rapidly disappearing appears certain; and it is suggested that the cause is, the ravages of the common rat. The Bush and country are swarming with them; they are found in the trees, on the ground, by the water and in the water. Rat life is rampant at the present moment in New Zealand. Birds' nests are found empty everywhere where they ought to have been tenanted, and are almost invariably robbed by the vermin; so that a progressive extinction of the native fauna appears to be an inevitable result of the undue increase of that prolific pest, the rat.

Singing mice have long been known, and the fact of their singing is beyond question, and have supplied the substantial evidence of a good income to the fortunate owners of these musical phenomena. Another well-authenticated instance has occurred at Ashcroft, in Kent,

* *See* his recent lectures on Comparative Anatomy.

of a mouse, which having been caught, continued its song in captivity. On disturbing it when asleep, a low chirping is heard such as is frequently made by young birds in a nest, but presently the sound begins to increase until it can be heard all over the room. The song is described as very pleasing, although rather monotonous, somewhat resembling the lower notes of a nightingale. The mouse seemed to appreciate its own singing powers, as it kept standing on its hind legs, and raising itself up as its lower notes grew louder. Mr. E. Newman suggests, as an explanation of these musical prodigies, that the performers are afflicted with some lung disease, perhaps tubercular phthisis, or that infirmity which in horses is called whistling. But whether this is a satisfactory explanation remains to be proved.

Mr. A. Fonblanque, of the British Consulate at Alexandria, has communicated to Mr. Darwin a notice of a curious birth which has lately taken place at Cairo—that of a foal produced by a mule. Mr. Fonblanque says, so great was the excitement at this unheard-of event amongst the native population, that it produced an official inquiry, a copy of which, together with a certificated translation, Mr. Fonblanque has forwarded along with his letter announcing the prodigy. The latter consists of the deposition of one Mohammed Effendi Ashmani, a veterinary surgeon, before the police at Cairo, on the 27th June, 1864, and states that on the previous day the said Mohammed had proceeded, in pursuance of instructions received, to the house of one Ibrahim, to examine a mule which had produced an offspring. It appears that the said mule had been covered by an ass, as the offspring is a jennet. The mule is twenty-two years of age, and as she has no milk, which is indispensable to maintain the jennet, directions were given for feeding it. Mr. Fonblanque does not believe that "any intentional deception has been practised. No attempt has been made to turn the affair into profit by exhibition or otherwise; in fact, it furnished considerable annoyance to the owner of the animal."

After several ineffectual attempts, the authorities of the Zoological Gardens succeeded in adding a live porpoise to the attractions of the Regent's Park. It was captured at Deal by some fishermen, and transported to London early in January, and, although somewhat bruised from attempts to escape capture, it gradually improved, and regained its appetite, taking its meals regularly. These consisted of live eels, which it caught for itself, also herrings, and other fish, supplied by the keeper at the end of a fishing-rod. It was hoped that the re-establishment of its health would have ensured it as a permanent addition to the collection, but unfortunately, during the frost, it suffered so much from exposure in its *shallow* pond that, to the great disappointment of all concerned, it died after a few weeks' confinement.

A gorilla, which was sent recently from Africa by M. Du Chaillu for the Gardens of the Zoological Society, unfortunately died on the passage to this country.

Dr. Lionel Beale, in continuing his investigations upon the tissues, has maintained some views of the relations of the round and caudate

nerve-cells, which are not without interest. In a paper read before the Royal Society, he remarks that the caudate cells are really not *cells* nor *vesicles*, in the ordinary acceptation of the terms, for there is no investing membrane and cell-contents, but the so-called cell consists of soft solid matter throughout. The nerve-fibres are not prolonged from the nucleus, but are continuous with the very material of which the substance of the cell is composed. From various observations upon the course taken by the tubes through the cells and into other fibres, he concludes that the typical anatomical arrangement of a nervous mechanism is not a cord with two ends—a point of origin and a terminal extremity, but a cord without an end—a continuous circuit. From the peculiar structure of the caudate nerve-cells, he thinks it improbable that they are *sources* of nervous power, while, on the other hand, the structure, mode of growth, and whole life-history of the rounded ganglion-cells, render it very probable that *they* perform such an office. These two distinct classes of nerve-cells, which are very closely related, seem to perform very different functions—the one *originating* currents, while the other is concerned more particularly with the distribution of these, and of secondary currents produced by them, in very many different directions. A current originating in a round *ganglion* cell would probably give rise to many induced currents in a *caudate cell.*

An egg of the New Zealand Moa has been found in the Middle Island under singular circumstances. A labourer who was digging the foundation for a house came upon the egg, and unfortunately, with his pick, broke some portions of the shell. It was in the hands of the skeleton of a Maori, who was buried in a sitting posture, with the egg resting in his hands, and held opposite to his head. The egg is about 10 inches long, and 6¾ inches in width, and of a dirty-white colour. It has been placed in a box and protected by glass, so that the injury is not perceptible, and the egg appears to be perfect. It has been suggested that this discovery does not tend to prove that the Moa has recently existed, inasmuch as the egg was probably in a fossilized condition; for the shell of the Dinornis, unlike that of the Æpyornis, is comparatively slight, and, therefore, likely to have been shattered by a heavy blow from a pickaxe, whereas the egg remains perfectly sound, except upon the side accidentally chipped. Probably the egg was intended as a provision for the journey to the realms above, or, as the Maories say, possibly to the regions below; but there appears to be no record of the custom of placing such objects in the hands of the dead.

Pisciculture is practised with much success in Belgium, and M. Schramm, the Director of the Botanic Garden at Brussels, has recently received a first-class medal from the Acclimatization Society of Paris, for his labours in this direction. The Society at Brussels has just completed the fishing of their pond in the Botanic Garden, for the purpose of obtaining a supply of ova for artificial propagation. Two hundred and fifty salmon and trout obtained in this manner furnished

about 40,000 ova, which were immediately placed in the hatching apparatus. The fish were from three to five years old.

Professor Agassiz has laid before the Paris Academy a remarkable paper upon the "Metamorphoses of Fishes," which he states are, according to his observations, as important as those of Reptiles (Amphibia). At the present time, when pisciculture is so much studied, it appears remarkable that such metamorphoses should not have been sooner observed, but Agassiz accounts for it by the fact, that the metamorphoses generally commence immediately after hatching, at which period the fishes die rapidly when kept in captivity. He says he is prepared to show that certain small fishes, which at first resemble Gadoids, or Blennioids, gradually pass to the type of Labroids and Lophioids; and that certain embryos, similar to the tadpoles of the frog or the toad, take by degrees the form of Cyprinodonts—that certain Apodes are transformed into Abdominal fishes, while some Malacopterygians (soft-finned) are changed into Acanthopterygians (hard-finned); and, further, that a natural classification of Fishes can be founded on the correspondence which exists between their embryonic development and the complication of their structure in the adult state. M. Agassiz lately discovered that the metamorphoses of some members of the family of the Scomberoids are still more unexpected. All icthyologists know the generic characters of the Dory (*Zeus faber*), and the peculiarities which attach it to the family of the Scomberoids. Another fish, less known, but more curious, which lives also in the Mediterranean, the *Argyropelecus hemigymnus*, has been generally classed with the Salmon family, or placed with the salmon as a subfamily. Systemic authors have generally considered the *Scomberoids* and *Salmon* as very different fishes, the first being Acanthopterygians, and the second a Malacopterygian. But the *Argyropelecus hemigymnus* is nothing else than a young *Zeus faber*. Agassiz says he expects ichthyologists to declare this opinion erroneous, but, in reply, he invites them simply to compare specimens of Argyropelecus with young Dories, 8 to 10 decimètres in length.

In connection with the discoveries of M. Agassiz, it may be remarked that observations of a similar tendency have been made on the Crustacea by M. Gerbe, in conjunction with M. Coste, from which it appears that the larvæ of the *Palinuri* are identical with the species of the curious genus *Phyllosoma* (glass crabs), possessing the same peculiarities, as absence of branchiæ, flattened membranous and diaphanous body, &c. There are differences, however, such as the absence of the false feet which are attached to the abdominal segments of the Phyllosoma, and of the caudal fin of five laminæ, which at first would appear to negative the resemblance. But these are only transitory differences, which are effaced in the course of the first four or five changes of skin. All the marine Crustacea, according to M. Gerbe, make their appearance in a larval form, and immediately after birth all of them undergo the first moult. But in no species, not even in the Lobsters, which of all Crustacea are hatched in the most perfect condition, does this first metamorphosis cause the appearance of the

lateral laminæ of the caudal fin, and the false feet. The organs remain latent, the latter until the second month, the former until the third. At each moult some organs become complete, others acquire more and more their normal form, whilst others make their first appearance to arrive subsequently at their final perfection. It is probable, therefore, that the same species of Phyllosoma in different moults, has been described under various names, and M. Gerbe feels assured that he will soon be able to prove that if the Phyllosomata of authors present more perfect characters than the larva of the Palinurus, as described, it is because they have undergone several metamorphoses, and, consequently, represent subjects in a more advanced state of development. *Phyllosoma*, therefore, bears the same relation to *Palinurus* that the Zoëa does to the Crab.

M. Guyon has communicated to the French Academy some researches upon the poison of Scorpions, from which he deduces that it is identical in its character with that of serpents, both affecting animals in a similar manner. Both poisons produce more violent effects upon small animals than on large ones, and on warm-blooded than upon cold-blooded ones. The scorpion's sting is followed by immediate violent pain, and general itching, tumefaction, and extravasation of blood into the subcutaneous cellular tissue. Tremblings, vomiting, and great prostration succeed. Respiration is accelerated, and coma ensues in fatal cases, with dilatation of the pupil. Tetanic spasms of the extremities (more frequent in birds than in mammals), and remarkable disturbance of the genito-urinary organs, also occur in many cases.

Dr. V. Hensen has shown that the Crustacea possess a delicate sense of hearing, and describes the organs by which this sense is developed. His researches have extended to twenty-eight species of crustacea. In the higher forms a delicate nervous filament enters a chitinous hair, which is connected to the rest of the chitinous skeleton in such a manner as to allow of vibrations under the influence of sonorous undulations. The extremity of the hair often penetrates between the otolites, or even into the interior of one. The otolites are thrown off at the periodical moult, together with the chitinous tunic, and are replaced by others, and the minute lapilli are introduced by the animals themselves into the auditory sac. In crustacea with a closed sac, however, they present a peculiar structure, but still they shed the auditory apparatus, which is reproduced anew. The *auditory hairs* are of three kinds:—1. Hairs with otolites; 2. Free hairs of the auditory sacs; and, 3, Auditory hairs of the outer surface of the body. The first are generally curved, and recall the setæ in the orditory organ of fishes. The Brachyura (crabs, &c.) have no otolites, but their auditory sacs are nevertheless furnished with hairs, of which he counted 300 immersed in the fluid of the auditory sac of the common shore-crab. Inasmuch, therefore, as auditory hairs may be thrown into vibration without the mediation of otolites, M. Hensen thinks it is probable that they may be equally capable of fulfilling their functions if they were placed on the surface of the body. These conside-

rations have led him to regard as acoustic organs certain hairs upon the surface of the crustacea, which present the same structure as the hairs connected with the otolites. They are especially numerous in those species, or in larvæ, which have no internal auditory organs, and are renewed at each moult. Their structure is much more complex than the other hairs of the surface, which latter are wholly devoid of any nervous cord. Supposing that each auditory hair was capable of being thrown into vibration by a determinate note, he subjected the matter to experiment, and found that on sounding different notes of the gamut certain hairs became indistinct by reason of powerful vibrations, while the neighbouring hairs remained perfectly still, or could only be made to vibrate by other notes.

M. Jourdain has investigated the eyes of the common starfish, and finds that they are more highly developed than is commonly supposed. Of the two fundamental types of the organ of vision, *viz. eidoscopic* eyes, which furnish images, and *photoscopic* eyes, which only are fitted for giving a general sensation of light and darkness, he gives reason to believe that in *Uraster rubens* there is a specialization of function which no doubt represents the highest type of organization of photoscopic eyes. Eidoscopic eyes are found in the Mollusca, Insecta, and Crustacea, and are connected with an expansion of a nerve of special sense, upon which luminous rays are isolated. The photoscopic eye is associated, in its simplest form, with blackish or reddish pigment, of definite structure, in connection with the nervous system, or only with the sarcodic mass, as in the genus Lycoris. But in the well-known pigment spots of the star-fish, situated in the interambulacral furrows, at some little distance from the extreme end of the rays, there is received a filament from the ambulacral nervous trunks, which filament becomes dilated into a ganglion on penetrating into the papilla. The papilla is surrounded by spiniform calcareous processes, which are separated from each other by muscles, so as to expose the visual organ to the rays of light; but when the processes are approximated over the oculiferous papilla, the eye is, so to speak, shut, either for the suspension of vision, or for the protection of the organ. With high powers of the microscope the papilla is seen to be hollowed into numerous little cavities, lined by pigment, and connected at the bottom with the nervous ganglion. These depressions are filled with a very transparent gelatinous matter, forming a slight projection at the surface of the tubercle, and terminated by a convex portion, like the cornea of the higher animals. The presence of this refractive substance gives the eye some claim to be considered as eidoscopic in its character; and it doubtless serves to collect and concentrate the luminous rays upon the impressionable pigment, and consequently to render the perception of light, and of its different degrees, more intense and perfect.

Dr. Cobbold, well known for his study of the Entozoa, has published a pamphlet (on a new Entozöotic malady) in which he foretells the almost inevitable increase of parasitic diseases in general, if the proposed extensive utilization of sewage be carried out. Referring to the

African "fluke" epidemic, he states, as proving the extensive prevalence of this disease in Egypt, that out of 363 *post-mortem* examinations conducted by Dr. Griesinger, these parasites were found in 117 cases, so that one-third of the entire population appears to suffer from their inroads. This parasite has made its appearance in this country, and it would appear that it is as prevalent at the Cape, at Natal, and in the Mauritius, as in Egypt. "In the advanced stages of the malady," Dr. Cobbold observes, "the afflicted individual must frequently evacuate the ova and their embryonic larvæ, which will do no harm if conveyed into a cesspool, or by a common sewer into the sea. But if scattered broadcast, they will be spread over thousands of acres of ground, placing the larvæ on conditions favourable for their next stage of growth, in which stage they will penetrate the bodies of land and water snails; after which there is every reason to believe that they will experience no greater difficulty in gaining access to our bodies here in England than obtains in the case of those same parasites attacking our fellow-creatures in Africa." And he foretells that in twenty years the parasitic malady would be as prevalent in this country as it is now in some particular sections of the African continent.

Two distinguished ornaments of our science have been added to the list of the dead during the last few weeks. The one was Dr. Falconer, described as one of the greatest Palæontologists who ever lived, and whose life, devoted to science, was brought to a close by disease contracted during his long residence in India, the scene of his chief labours. The second was Gratiolet, Professor of Zoology at Paris, whose researches on the comparative anatomy of the nervous system, and structure of the brain, had placed him in the foremost rank of scientific men of the present day. He died of apoplexy, on the 17th February, not having reached his fiftieth year.

Proceedings of the Zoological Society of London.

At each meeting of this Society numerous communications are read, extending our acquaintance with the fauna of some distant part of the world, or rendering the knowledge of our own fauna more systematic and precise. As usual, Dr. J. E. Gray has been foremost in his industrious accumulation of facts. Papers have been communicated by him on a new species of Whalebone Whale (Eschrichtius robustus), founded on a specimen stranded on the coast of Devonshire in 1861, and portions of whose skeleton have been obtained for the British Museum; also upon another species (of the Right whale), whose atlas and cervical vertebræ appear to indicate the existence, in the Antarctic Seas, of a new form of this group. The specimen has been named *Macleayius australiensis.* Another new species of whale has also been described by Dr. H. Burmeister, founded upon a skeleton in the Museum of Buenos Ayres, and called by its describer *Balænoptera patachonica.*

Dr. Gray has also brought forward important revisions of two families of Carnivora—the Ursidæ and Mustelidæ—from specimens in the British Museum. Of the Ursidæ there are ten genera and twenty-two species, nine inhabitants of the old and twelve of the new world, while one is common to both. Of the Mustelidæ there are twenty-three genera and forty-seven species, of which ten are peculiar to the new world.

Dr. Kirk, the companion of Livingstone, enumerates the mammals, sixty-seven in number, met with in the Zambezi region of Eastern Tropical Africa, amongst them a bat and an antelope new to science.

With regard to birds, Professor Owen has contributed a ninth memoir upon Dinornis, chiefly descriptive of the skull, and founded upon the skull discovered, with an almost entire skeleton of the bird, in the Valley of Manuherika, Otago, and now in the museum of the Yorkshire Philosophical Society. Professor Bianconi, of Bologna, communicated a letter relating to the systematic position of the extinct Madagascan bird, the *Æpyornis maximus*, which he was of opinion should be referred to the Vulturidæ. New species of birds have been added from Rodriguez, by Mr. Newton; from Benguela, by Mr. J. J. Monteiro; and from Australia, by Mr. Gould, discovered during the recent exploration of the interior of that country. The discovery of some bones of a large species of Dodo in a cave at Rodriguez, by Mr. Newton, is also worthy of notice; and the occurrence in this country, for the first time (near Newbury), of the Carolina Crake (Porzana Carolina). A remarkable Australian lizard (Moloch horridus) is stated to have been recently captured alive in Jersey, to the no small excitement of the islanders, and a photograph of the intruder was exhibited by Mr. Sclater. The fishes of Cochin, on the Malabar Coast of India, have been described by Mr. Francis Day, in a memoir devoted to the Acanthopterygii, of which 120 species are enumerated, including several new to science; and Dr. Günther has presented an account of his researches into the British species of Salmonoid fishes. He states that the genus *Salmo* is essentially an Arctic group, inhabiting the northern portions of both hemispheres, the species becoming more abundant upon receding from sub-tropical to temperate latitudes. He is disposed to believe that the species to be found within British waters are more numerous than hitherto suspected, and he has made out four new species of the non-migrating group of true *Salmo*, besides identifying several others heretofore imperfectly distinguished. He distinguishes five of the sub-genus Salvelinus (charrs) inhabiting Windermere (the original habitat); Llanberis, Scotland; and Loughs Melvin and Eske in Ireland, respectively. Of the sub-genus *Salmo*, three are migratory species, *viz.* the true Salmon, the "Sewen" of South Wales, and the Sea-trout of Scotland; while eight are non-migratory species—*viz. S. fario* of England, *S. Gaimardi* of Scotland, *S. Levensis* of Loch Leven, and *S. ferox* or Great Lake Trout; with the four new species above mentioned, called respectively *S. nigripennis*, inhabiting mountain lochs of Wales, *S. orcadensis* (Orkney

lakes), *S. brachypoma* (Firth of Forth), and *S. stomachicus*, (Ireland).

Several interesting additions to the Society's collection have been made, *viz.* a fine male Mantchurian Deer from Mr. Swinhoe; and the prong-horned Antelope of America (Antilocapra Americana), the first instance of this animal's having reached Europe alive. Dr. Bennett, of Sydney, has in the gardens of the Acclimatation Society of Sydney, N.S.W., a specimen of the Lyre bird (Menura Novæ Hollandiæ), intended to be transmitted to London by the first opportunity. Finally, Dr. Schlater reports that there are in the gardens seventy-four specimens of the Quadrumana, belonging to forty-three different species, amongst which are several of great rarity.

REVIEWS.

THE GEOLOGICAL SURVEY OF INDIA.*

It cannot but be considered highly creditable to the East India Company, that during their rule over that great limb of the British Empire, Hindostan, they did not neglect projects which had reference to the future permanent benefit of the whole country, but of whose immediate utility in a mercantile point of view there could be little prospect. The establishment of a Trigonometrical Survey, to be followed in course of time, after the example of the mother-country, by a Geological Survey, could scarcely be looked upon as likely to be a good investment for capital (so to speak) at the time when these Surveys were projected. Yet even now they are bearing fruit, in giving facilities for laying out lines of railway, for the sale of public lands, and for defining the limits of formations producing coal, iron, and other minerals. The value of such undertakings to the cause of science and the advancement of the arts need not be insisted upon here; so general is the recognition of the importance of good Topographical and Geological Surveys, that there is scarcely a country in Europe and America, or a dependency of the British Empire, where they have not been originated and sustained by their respective Governments.

The Geological Survey of India has been in existence about seventeen years, under the superintendence of Dr. Oldham, who previous to his appointment had the advantage of several years' experience as Director of the Geological Survey of Ireland. His staff of assistants has been gradually augmented, and is largely drawn from that country; and it is somewhat remarkable, that in looking through the Report of Dr. Oldham, we do not recognize the name of a single Scotchman! We do not, of course, venture upon so rash an inference as that amongst the dozen officers or so of the Indian Survey, there is not one single native of that fortunate country, which supplies men to most of the good appointments all over the world. We trust, indeed, that such is not the case, as it would speak but ill for the prospects of the Indian Survey.

The Geological Survey is now at work in three distinct regions of the Indian Peninsula, about equally distant from each other. During

* 'On the Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot.' By William King, junior, and R. Bruce Foote. Calcutta: Thacker. London: Williams & Norgate.

'On the Structure and Relations of the Southern Portion of the Himalayan Ranges between the Rivers Ganges and Ravee.' By H. B. Medlicott, A B., F.G.S. Same publishers.

'Annual Report of the Geological Survey of India for the year 1863–4.' By Thomas Oldham, LL.D., Superintendent. Calcutta: O. T. Cutter.

the year 1863, a tract of country stretching across the peninsula from the Gulf of Cambay to the mouth of the Ganges has been completed. This was an object steadily kept in view during several years, and as the relations of the rocks along this belt have been determined, a basis has thus been formed for the extension of the work towards the north and south. Another belt, farther south, in the parallel of Kurnool, Bellary, and Goa, is now in course of examination, and will form a portion of the work of several years to come. In the meantime, the rocks along the southern flanks of the Himalaya are being mapped, forming a third belt to the northward, so that we presume the intention is to extend the work in a series of parallels over the intervening districts until they form a junction.

For a region of such vast extent as India, and of the relationship of whose rocks we have so imperfect a knowledge, the above plan may be—and doubtless is—the best. In a country, however, such as England, in which the formations are arranged in so symmetrical a manner, that we can make a traverse from the oldest to the newest formations along a given straight line, the obvious course is to commence with the former, and work up to the latter ; and this is the general plan which has been adopted by the English surveyors. But in India it is otherwise, and although the Himalayas offer an apparent base, yet such are their dimensions, both lengthways and vertically, such the physical difficulties likely to be offered in any attempt to unravel their structure, that at least one generation would have passed away ere such a Herculean task could have been accomplished. We therefore assume that the apparently unsystematic plan of operations which is represented on the Index Map accompanying Dr. Oldham's Report (which also shows certain favoured spots of which surveys have been made, scattered at wide intervals over the Indian Empire), has been adopted, in obedience to economical, scientific, or perhaps Imperial requirements. Some of these are indeed apparent from the Reports of the surveyors themselves, as we find their regular work frequently interrupted by orders from Government to proceed to some spot, mayhap many hundred miles distant, to report on some special district. Thus we find that Mr. W. T. Blanford, during the year 1863, was detached on temporary duty to examine a reported coal-field in Sinde ; and Dr. Oldham himself, while engaged in company with Mr. Medlicott in examining a very important area, extending from Monghyr to the Sone, was ordered to proceed at once to the Punjab, to examine and report upon the deposits of so-called coal in the Salt range. Such interruption must sadly interfere with the steady progress of the Survey ; and now that most of the real or imaginary coal-bearing districts have been visited by the officers of the Survey, it is to be hoped that their systematic labours will be less frequently interfered with.

The districts treated of in the two memoirs before us lie almost at the two extremities of the Peninsula. That described by Mr. Medlicott embraces an area of 7,000 square miles, in a region peculiarly attractive from its physical features, being composed of those picturesque ranges which form the frontiers of the Himalayas in the

Punjab. The Sub-Himalayan hills are often of considerable elevation, reaching altitudes of 10,000 or 12,000 feet, and culminate in the Peak of Chor and in the Dhaoladar ridge. This latter ridge, composed of granitoid gneiss, and ranging nearly in a north-westerly direction, forms, in the opinion of the author, the extreme north-westerly prolongation of the "Eastern Himalaya," from which, however, it is severed by the deep valleys of the Beas and Sutlej. To the north-west, the Dhaoladar ridge sinks down, and is terminated along the valley of the Ravee, while the "Western Himalaya" rises to the north of this ridge, and ranges in a nearly parallel line between the Chenas and the Indus. Mr. Medlicott has good Geological reasons for the view he adopts regarding the line of division of the Eastern and Western Himalayas; and it is an interesting fact, first noticed by Colonel Cunningham, that the subordinate hills of the Western Himalaya range in lines parallel with the central axis, while those of the Eastern run out at right angles from the main ridge. The causes of this distinction are considered to lie in certain changes in their Geological structure.

Mr. Medlicott separates the rocks of the region of which he treats into two great groups, each of which is capable of farther subdivision—namely, "The Himalayan" and "Sub-Himalayan." The stratigraphical distinction between these two great groups is most marked. The former composes the interior central range (as far as he has examined it), and consists of limestones, shales, sandstones, slates, quartzites, schists, and gneiss; the latter consisting in the lower part of shales, with nummulitic limestones, and passing upwards into an assemblage of strata in which sandstones and conglomerates largely predominate. Of the age of the "Himalayan" group no opinion can at present be formed, owing to the almost entire absence of fossils. The author has only succeeded in finding a few obscure impressions of bivalve shells in a band of limestone, which do not throw any light on the subject; but in the succeeding group of the "Sub-Himalayan" beds, we pass from rocks of whose age we can only form vague conjectures to those of an age strongly defined in the Geological series. Between the two groups there is in all probability a vast gap in time, as M. D'Archiac refers these Himalayan beds, though with hesitation, to the Devonian period. The shales and limestones of the "Sub-Himalayan" series contain shells* and nummulites, which enable us to refer these beds to the early Tertiary age with the same amount of certainty that we refer a coin stamped with the effigy of one of the Cæsars to its period in Roman history.†

From what has been stated above, it is not to be inferred that we are unacquainted with the age of any of the rocks which compose the lofty range of the Himalayas. Through the labours of Captain Strachey and other explorers we have been made acquainted with groups, some of which rise into the loftiest altitudes, charged with

* A list of which is furnished by Dr. Kane, pp. 99–100.

† For the sake of the general reader, it may be explained that "nummulite" means a stone-coin; and the stone of which the Pyramids are built is mainly formed of nummulitic rock. J. B. Jukes's 'Manual of Geology.'

fossils referable to the Silurian, Triassic, and Jurassic ages. Thus the highest passes into Tibet, at elevations of 20,000 feet, are formed of slates and limestones, containing *Asaphus*, *Cybele*, *Cyrthoceratites*, and other Silurian forms; beyond these are limestones, with *Ceratites* of the Muschelkalk, while beds with organisms resembling those of the Lias, Cornbrash, and Oxford clay follow in succession.

The whole of these formations of the two groups have undergone an extraordinary amount of disturbance. The beds are often vertical, and even inverted. In other cases they are broken by faults, and with such physical and stratigraphical obstacles to contend against, we cannot but consider that much credit is due to the author for disentangling the complicated structure of these rocks.

The "Subathu" beds are followed by the "Nahun" and "Sivâlik" rocks, which are somewhat similar to each other in character, being principally sandstones and conglomerates of great thickness; they have, nevertheless, a very marked line of division. This is illustrated by the section in the Narkunda which forms the frontispiece to the memoir. The upper series of sandstones seems to have been deposited against, and upon, a denuded surface of the lower series, which apparently formed a line of high cliffs and hills facing the open sea to the south. The break thus shown between the two groups indicates a second period of elevation in the Himalayan range. The Sivâlik beds are in turn succeeded unconformably by the nearly horizontal strata of the Ganges valley.

It would, of course, be hazardous to draw any general conclusions regarding so comprehensive a subject as the upheaval of the highest range of mountains in the world, from an examination of a limited portion of the entire length; and Mr. Medlicott very properly qualifies his remarks on this topic with the proviso, that they are open to subsequent alteration. Nevertheless, his views are novel and well supported. The usual opinion, founded on the fact that the Tertiary sandstones of the Sivâlik group dip towards the "Himalayan" beds, is that these older rocks are upheaved along an enormous fault or fracture. The author, however, seems to consider that the direction of the dip is due to foldings arising from enormous lateral pressure, and that the line of contact is not strictly a fracture, but an original margin of deposition. The discordances amongst the Tertiary beds themselves are evidence of a succession of elevations at intervals; and it would appear that the whole of the formations along the flanks of the mountains have, at a very recent period, been subjected to a process of crumpling, caused, as the author supposes, by the falling in to a certain extent of the entire mountain range.

In the case of the memoir of Messrs. King and Foote, we have not the advantage of a map.* The description of the district is, however, sufficiently clear to enable us to dispense, for the present, with a document so essential to a thorough understanding of the subject. There are, besides, several coloured longitudinal sections, which convey at a glance an idea of the general structure of the country.

* The map is expected to be published ere long.

The country treated of consists for the most part of highly-inclined metamorphic rocks, principally gneiss, with bands of crystalline limestone, trap dykes, and magnetic iron. The Geological age of these rocks is altogether uncertain, and they are succeeded by the Cretaceous and Post-Cretaceous formations of the Payen Ghat, or low country of the Carnatic. These latter form extensive plains or terraces, stretching from the interior to the coast in some places, while in others they are overlaid by very recent deposits of fluviatile, or marine origin, in which shells identical with those now inhabiting the neighbouring sea have been found. The alluvial deposits of the deltas of the Cauvery, Punniar, and Guddelom rivers are very extensive, and owing to their liability to floods from the rivers themselves are rescued from the curse of barrenness which overhangs the sandy plains by which they are bounded. In the interior, the crystalline and metamorphic rocks rise into several lofty ranges, belonging to the Eastern Ghats, of which the most distinguished are the Shevaroys, which, in the Green Hill Ridge, reach an elevation of 5,260 feet. This mountain is deeply indented by ravines, especially that of the Vaniaur river, a tributary of the Punniar. Along the sides of this ravine nearly perpendicular walls of bare rock rise to a height of a thousand feet, and the authors speak with rapture of the grandeur of the views along the road from Yercaud to Shenguttapady from the brow of these splendid precipices.

Space forbids a further reference to the general Geology of this interesting region, though there are several points upon which we should gladly linger. We therefore hasten on to notice that special feature which renders the Salem district almost unique in a mineral point of view. We refer to the wonderful hills of magnetic iron ore, which have rendered this district famous from very ancient times. These iron-beds occur in many places throughout the country of Salem and South Arcot. They are interstratified with the gneissic, or metamorphic rocks, following their foldings, or running for miles along the ridges of the hills with marvellous persistency. In the district under consideration there are four distinct groups of these iron-beds, some of which, as that of the Godumullay hills, form the serrated crests of the ridges, rising upwards of 1,200 feet above the valleys. On the northern side of this ridge, the iron-rock suddenly terminates in a splendid precipice several hundred feet high, overhanging in some places. These massive cliffs form the subject of the frontispiece to the memoir.

The most remarkable of these masses of magnetite lies just beyond the western limits of the district, and is therefore described in the appendix—it is the ridge of Kunjamullay.

The ridge attains an elevation of 2,000 feet above the sea, and of 1,000 above the surrounding plain. It is of an elongated form, four miles in length; and around its flanks, several beds of magnetic iron crop out in a series of oval rings, imbedded in garnetiferous gneiss and other schistose rocks, and dipping at every point towards the centre or axis of the ridge. From this description it will be apparent that the ridge is coincident with the axis of a synclinal fold, and that

the bed of ore which plunges inward on one side rises to the day on the other. Four or five bands of ore have been observed, and can be traced at intervals, through the thick scrub all round the circumference. The two lowest beds are each about 50 feet in thickness; and the authors remark that they are exceedingly conspicuous even when seen from a distance, especially when the morning or evening sun deepens the shadows, and lights up the projections. At such times these iron-beds may be seen encircling the hill in sharply-cut terraces of grey or purple colours. From the base of the hill, and extending for a distance of two miles or so, the ground is strewn with rounded blocks of ore, while the sides of the hill itself are in places thickly coated with a *talus* of the same material; in fact, nature has here carried out mining operations to such an extent, that the largest furnaces might be fed for years with the rough-hewn ore.

These beds of iron follow all the convolutions of the schistose rocks with which they are associated; and their laminæ of quartz are observable in hand specimens alternating with those of ore. The average yield is about 55 per cent. of pig-iron, which for every ton smelted requires 13¼ tons of charcoal. The steel made from this ore by the natives is of the finest description; and we have been informed by an English officer long resident in that district that there is documentary evidence to show that the famous Damascus steel, and those scimitars of whose wonderful exploits we read in the 'Arabian Nights,' were wrought out of the ore of these hills. Be that as it may, there is no question as regards the degree of temper to which the native craftsmen, by their rude and simple process of manufacture, are able to bring the metal, which cannot be surpassed, if equalled, by the European, with all his aids and appliances.

The ore is worked by the British Porto Novo Company, at Poolamputty, on the left bank of the Cauvery. It has to be conveyed from 20 to 25 miles before smelting, and when manufactured, is carried down the river during floods. The fuel is charcoal, which appears to be fast decreasing from the wasteful manner in which the scrub wood is used up, combined with the general neglect of planting. Government has for a long while established a Forest Conservancy Department; but as yet it has had little power to materially diminish the evil.

The memoir of Messrs. King and Foote we consider to be an excellent specimen of what a Geological Survey Memoir of an Indian district should be. It is carefully and clearly written, well arranged, and treats of those collateral subjects of climate and physical geography which depend so greatly on the geological conformation of the country.

In Mr. Medlicott's memoir there is (as it seems to us) a certain want of conciseness and methodical arrangement of the subject. We object to two such terms as "Sub-Himalayan" and "Infra-Himalayan" being applied to designate two series of strata, as being likely to cause confusion in the mind of the reader; and there is a degree of vagueness in the wood-cut sections which is highly embarrassing. Perhaps the engraver, and not the author, is responsible for

this defect, as we are well aware how difficult it is for an unscientific artist to reproduce on wood the designs of the naturalist. We are not, however, disposed to be critical on a work which has been carried out under circumstances of more than ordinary difficulty, and in spite of physical obstacles with which we Englishmen are happily unacquainted.

THE UNITED STATES COAST SURVEY.*

Through the courtesy of the Smithsonian Institution, at Washington, we have been favoured with the volume containing the Report of the Coast Surveyors for 1861—a year which will be for ever sadly memorable in American annals. The Survey, which was commenced in 1832, had been pursuing its quiet and peaceful labours throughout the whole extent of coast line, extending from Passamaquoddy Bay in the State of Maine, to the coast of Texas in the Gulf of Mexico, and along the coasts of Oregon and California on the western seabord. At various points throughout a line of more than 2,000 miles, small parties were engaged in plumbing the depths, triangulating and sketching the inlets of the coast, bays, and harbours, or determining the Lat. and Long. of conspicuous points. No less than 9,050 of these had already been tabulated, and so steady and undeviating had been the progress made in mapping the coast line, that in eight years (or in 1869) the work was intended to have been completed, when that fatal war which has deluged with blood half a continent, broke out, and at once terminated surveying operations along the whole Atlantic seabord, with the exception of that portion belonging to the New England States. At the stations along the coast of the Southern States some of the property of the department was seized, and the liberty of the officers placed in jeopardy. Two vessels were seized in Charleston Harbour, and a few other slighter losses were sustained; but, on the whole, it may be said that the officers and men made good their retreat, having received instructions to leave their stations whenever the attitude of the State authorities appeared threatening.

It is worthy of remark, that amongst all the naval officers engaged in this department of the public service, not one joined the Confederate cause; and Professor Bache very naturally pays a high tribute to their "loyalty," as many of them volunteered for active naval duty. This, however, only corroborates what has been frequently observed—that at the breaking-out of the war, the Northern side was supreme in the naval arm; while the Southern had the advantage in the superiority of officers for the army. Amongst the naval officers engaged in the Coast Survey in 1861, was Commander D. D. Porter, who recently commanded the two naval attacks on Fort Fisher, and to whose further career the public are looking with some degree of

* 'Report of the Superintendent of the United States Coast Survey for 1861.' Washington Government Printing Office.

interest. Even before the outbreak of hostilities, he appears to have been a marked man, for Professor Bache, on losing his services as superintendent of the hydrographic work of the Western coast, speaks of "the strength of his indomitable will," and pays a high tribute to his "well-known energy and intelligence, which gave large promise of public benefit."

The topography of the coast is now completed along nearly three-fourths of the Eastern seabord of the United States, as they were in 1860, and the hydrography has extended *pari passu.* Of the maps which are published there are three classes. The first is on a scale of $\frac{1}{80,000}$, embracing the coast as far inland as the nearest main road, and a considerable distance at sea. These are highly-finished charts. The second is of a more general character, and on the much smaller scale of $\frac{1}{400,000}$, or about six miles to an inch. These are intended to enable the navigator to recognize the general features of the coast, and they contain soundings to a depth of at least 120 fathoms seaward, as also selected inshore ones, so as to give a general idea of the form of the bottom in bays, estuaries, and harbours. The third class are special charts of harbours, anchorages, &c., on various scales from $\frac{1}{5,000}$ to $\frac{1}{80,000}$ of the natural size, with minute details of soundings, tides, and currents. Besides the above, a new series of charts, planned in 1857 by Mr. Boshke, is in course of construction, by which the whole coast line of the Atlantic and Gulf of Mexico will be portrayed in 32 charts, on a scale of $\frac{1}{200,000}$, or about three miles to an inch. These will be arranged so as to be capable of being mounted in a continuous sheet, and are intended to decorate the walls of public buildings, offices, and dwellings.

During the progress of the Coast Survey, special observations have been made with a view to determining the outline, depth, and other phenomena of that mighty ocean-river, the Gulf Stream, to whose beneficent influence the British Islands are so largely indebted both for the humidity and mildness of their climate. The hydrography of the Gulf Stream is now very generally understood, especially from the writings of Captain Maury, of the Confederate Navy. There is one point, however, indicated in Plate 28 of "The Report," which we do not recollect to have previously observed, and which may therefore have escaped the notice of others; we refer to the position of the axis of the stream with respect to the outer and inner "Cold Walls." The axis (or line of greatest velocity at the surface) occupies a very peculiar position; for it is not, as might perhaps have been expected, in the centre, or even near the centre between the two walls, but throughout its entire length, from near the extremity of Florida to the banks of Newfoundland, it occupies a position from one-third to one-sixth of the breadth of the stream towards the American shore: in other words, it is from three to six times farther from the outer wall than from the inner. Into the causes of this feature in the current of the stream we cannot here fully enter. It is evident, that all along its course till it assumes its easterly direction across the Atlantic, the waters are pent up against the north-western wall. The forces

driving the waters northward are here combined with those carrying them eastward, and on the resulting motion the form of the coast exercises a powerful influence. The general effect is to produce a cross section, similar to that of a river which is bent from the straight course by a bank with a continuous curve.

Notwithstanding the continuance of the war, the Coast Survey is not, we believe, abandoned; but is prosecuting its labours along the New England Coast. No later Report than that we are now reviewing has come into our hands. Since the outbreak of hostilities, the Federal Government has taken good care that documents of such value as coast charts shall not fall into other hands than those for whom they are intended. Consequently, the distribution of copies, which, as authorized by a resolution of the Senate, had amounted to the liberal number of 6,200 up to the year 1860, has been greatly curtailed. For ourselves we need scarcely remark, that whatever our private leanings may be in reference to the two great parties in the struggle, any documents entrusted to our care shall be scrupulously guarded, and the confidence placed in us will not be abused; with this assurance, we hope to be favoured with copies of the later Reports, which will receive the notice they so well deserve.

THE PLURALITY OF WORLDS.*

Amongst our Original Articles in the present Number will be found a Review of the chief scientific facts upon which the believers in the plurality of the habitable worlds base their creed; and if any of our readers should be induced by a perusal of the essay to devote themselves to the study of that important subject, we recommend to their notice the book by M. Flammarion, editor of the Paris journal, 'Cosmos,' of which the title is given at the foot.

We shall presently speak of the merits of this work; but it is partly in consequence of its chief defect that our article has appeared. That defect is the introduction into the argument of an amount of extraneous and, as it appears to us, irrelevant matter, which must materially weaken its force with thinking men accustomed to reason only from well-established scientific data.

To the historical portion of the subject the author devotes nearly sixty pages, citing, it is true, the opinions of many observers whose views may fairly be employed as evidence; but in his anxiety to plead his cause fully, he has given weight to the opinions of heathen writers, which, from their fabulous character, might just as fairly be thrown into the scale of his opponents. Next to this imperfection comes another; namely, the large amount of space which is occupied by

* 'La Pluralité des Mondes Habités, Étude où l'on expose les Conditions d'Habitabilité des Terres Célestes, discutées au point de vue de l'Astronomie, de la Physiologie et de la Philosophie Naturelle.' Par Camille Flammarion, Ancien élève-Astronome à l'Observatoire Imp. de Paris, &c., rédacteur du 'Cosmos,' &c. Paris: Didier & Co.

speculations upon what *may be* the conditions of existence in the other planets, and of this defect the author seems to be well aware; for after dragging his readers through page after page of 'Scientific Romances,' he says*—"Ces digressions s'éloignent un peu trop, en vérité, de l'esprit de cet ouvrage;" and then he proceeds to launch them into "systèmes imaginaires," with a description of which he manages to fill thirty pages more.

Neither does he proceed with the caution that should characterize the discussion of a subject still in the infancy of its history, and he often jumps at conclusions to which every thoughtful man of science must demur. Who, for example, could fail to smile at the author's complacency when he announces as one of the results of the inquiries through which he has conducted his readers,† "L'examen comparatif de l'habitation des mondes a établi qu'une grande diversité de nature règne parmi les hommes des planètes?" Finally he gives us an Appendix of 116 pages, whereof 53 are devoted to the Christian doctrine and its agreement with the one of which he treats; but here he cannot be accused of a want of caution, for he confines himself almost exclusively to reviewing the opinions of others, and a remarkable reason for encumbering a purely scientific inquiry with a mass of sectarian considerations will be found at the conclusion of this portion of his work‡—"Nous ne pouvons cependant nous empêcher de dire, en terminant, que toutes ces discussions métaphysiques nous paraissent superflues et stériles: elles ne sont utiles ni à la gloire de l'Astronomie ni à l'autorité de la Religion." (!) In fact, if all these "superfluous" matters had been omitted, the proportions of the work would have been materially reduced to the great advantage of the argument, for there is little doubt that all the sound scientific information we possess respecting the habitability of the other planets, coupled with everything worthy of being considered as evidence in history and metaphysics, might be compressed into one-fourth of the space devoted to the subject in M. Flammarion's book.

But even the defects to which we have referred are clearly the result of a desire on the author's part to treat his subject with fullness; and there is throughout unmistakable evidence of great conscientiousness in the expression of his own views, as well as in his criticisms of others'. The author's astronomical argument, as might be expected from his position in the scientific world, is posted up to the latest date, and he treats of the possible fertility (and therefore habitability) of the side of the lunar hemisphere which is always hidden from our sight; of the spectral researches into the constitution of some of the heavenly bodies, &c.; but on the other hand, his views upon geological and biological matters must be received with caution, and his observations carefully considered, for on these subjects he does not always exhibit the requisite amount of knowledge.

His thoughtful survey of the present condition of the human race, with its imperfections; his inquiries (conducted in an admirable tone)

* P. 266. † P. 319. ‡ P. 469.

into the dispensations of Providence, and the improbability of this Earth being the only one where creatures exist which partake of the Divine nature, and his treatment of cognate subjects, form as solid arguments in favour of the habitability of other worlds as the physical data that he has collected to prove his point.

He considers the Worlds around us to be stations in Heaven; the regions of our future immortality, if we may be permitted to use the expression. They constitute the Heavenly home of many mansions, and to them he believes his ancestors to have passed; "Nous reconnaissons," he says,* "celui que nous habiterons un jour. Toute croyance pour être vrai doit s'accorder avec les faits de la nature. Le spectacle du monde nous enseigne que l'immortalité de demain est celle d'aujourd'hui et celle d'hier; que l'éternité future n'est autre que l'éternité présente; c'est là notre foi, notre paradis; c'est l'infini des mondes."

Irrespective of the value of this book, as regards its avowed aim of proving the habitability of the other spheres, it will be found useful for the amount of tabulated information which it contains regarding the planets; and the illustrations, which are well executed, will serve along with the text to convey to a young student a very excellent idea of the Solar system.

The language is clear and simple, and in many places it rises to a standard suited to the sublime theme of which the volume treats. We shall be glad to welcome a translation of the work in our own language.

THE CULTIVATION OF QUININE.†

The cultivation of Quinine in Java and British India has been treated of lately by Dr. J. E. De Vrij. The Quinine-yielding trees grow at various heights above the level of the sea in the primitive forests of the contiguous republics of Venezuela, New Grenada, the Ecuador, Peru, and Bolivia. The medicinal properties of the trees have been known from time immemorial to the natives of those countries, but it was not until 1632, that the curative powers of Quinine were known in Europe. The cure effected by the remedy in the Countess de Chinchon, wife of the Viceroy of Peru, brought it into greater notice. The trees were included by Linnæus, in the Genus Cinchona, or, as Dr. De Vrij and others call it, Chinchona. Various species of Cinchona yield the febrifugal alkaloids, Quinine, Cinchonine (Chinchonine), Quinidine, and Cinchonidine. Of these Quinine is the most powerful, and hence the most valued. The species which yields it in largest quantity, is Cinchona Calisaya. Great apprehensions were entertained recently that the trees in South America would ultimately become

* P. 398.

† 'On the Cultivation of Quinine in Java and British India.' By Dr. J. E. De Vrij, late Superintendent of Chemical Researches in Dutch India. London, 1865.

extinct in consequence of being stripped of their bark, and no means being taken to replace the trees which were felled for decortication. The Dutch Government introduced the Quinine trees into Batavia in 1852. The original plant died, but two slips taken from it to Buitenzorg, continued to thrive, and in 1862 acquired a height of 20 feet. M. Hasskarl was appointed to take charge of collecting Quinine plants and seeds for Java. He landed at Batavia on 13th December, 1854, with 21 chests of Quinine plants, and he was entrusted with the management of the plantations. In 1856, he was succeeded by M. F. W. Junghuhn, who died in 1864.

Besides the true Calisaya bark, there were several other species cultivated, and among them a new species which received the name of Cinchona Pahudiana, after M. Charles F. Pahud, Minister of the Colonies, in the Netherlands. The plants were at first propagated by seeds and the process was slow, but Mr. M'Ivor, at Ootacamund, subsequently ascertained that the plants could be much more rapidly and extensively propagated by slips, and this led to a rapid increase. When M. Junghuhn undertook the management in July, 1856, there were 251 living plants, 1,650 slips; but at the end of December, 1863, there were 1,151,810 Quinine plants in the Java plantations, of which 539,050 were growing in the open air, and 612,771 in the sprouting beds and nurseries, besides nearly 7,000 live slips. The plants consisted of:—

Cinchona Calisaya . . .	12,090
„ lancifolia . . .	251
„ succirubra . . .	89
„ lanceolata . . .	128
„ micrantha . . .	1
„ Pahudiana . . .	1,139,248

These were distributed in plantations varying from 4,440 to 6,830 feet above the level of the sea.

In 1855 an unsuccessful attempt was made to introduce the Quinine trees into British India. In 1859, Mr. Clements R. Markham proceeded to South America in order to procure plants for India. The plants transmitted by him to Ootacamund died, but he made arrangements for the transmission of plants and seeds, which have now been successfully cultivated at Darjeeling, at the foot of the Himalaya; at Hakgalle, near Newera Ellia, in Ceylon; and at Ootacamund, in the Neilgherries. The Darjeeling plantation is under the charge of Dr. Thomas Anderson, superintendent of the Botanic Garden at Calcutta, and in 1864 it contained about 20,000 plants. The Ceylon plantation, 5,200 feet above the level of the sea, is managed by Mr. M'Nicoll, under the superintendence of Mr. G. H. K. Thwaites, Director of the Botanic Garden at Peradenia. At the end of 1863 this plantation contained 22,050 Quinine plants. The plantation at Ootacamund, 7,500 feet above the level of the sea, as well as a branch one at Neddiwuttum, is superintended by Mr. M'Ivor, who has done much by his mode of cultivation to promote the increase of the trees in India. In 1861 there were 172 young plants at Ootacamund, and in 1863 they had increased to 277,083. They were chiefly C. succirubra, or the red bark. An important im-

provement in Cinchona cultivation, introduced by McIvor, was planting the trees on fully-exposed open spots, and not under the shade of other trees. The woods were cleared away in the first instance, and then the Cinchonas were planted. The effect of exposure to the sun is the production of Quinine in larger quantity, as might have been expected. Mr. McIvor finds that the young branches supply a bark which yields Quinine. He expects before the end of December, 1865, to forward to Europe between 3,000 and 4,200 lbs. weight of Quinine bark, the yield of 16,000 plants set at Neddiwuttum in September, October, and November, 1862. Dr. De Vrij concludes by giving the following contrast between the Dutch and the English mode of cultivation:—"As the Quinine trees in Java must, according to the present mode of cultivation adopted in that island, be at least thirty years old before they are fully capable of yielding a good quality of bark, I very much doubt whether any capitalists would be found willing to employ their capital in that way for so long a period, and I feel bound, therefore, to answer the question in the negative. The English system, on the other hand, which admits of good interest on capital within four years at the most, and which continues regularly progressing in that respect, is certainly one which prepares the way for the transfer, in due course of time, of the cultivation to private industry."

MICROSCOPIC FUNGI.*

Mr. M. C. Cooke has produced a work on various Microscopic Fungi, more especially those concerned in the production of diseases in plants, which are known under the names of rust, smut, mildew, and mould. These minute organisms are too often passed over as objects of no interest or importance, and even by scientific men they have been sadly neglected. The author remarks:—"Is it not a shame that more than 2,000 species of plants should be known to exist, and constitute a flora, in a nation amongst the foremost in civilization, and yet be without a complete record? It is, nevertheless, true that hundreds of minute organisms, exquisite in form, marvellous in structure, mysterious in development, injurious to some, linked with the existence of all, are known to flourish in Britain without a history or description in the language of, or produced in, the country they inhabit. It is also true that the descriptions by which they should be known, of hundreds more, lie buried in a floating literature where the youthful and ardent student needs not only youth and ardour, but leisure and perseverance unlimited, to unearth them."

The whole number of species of Fungi described in the sixth edition of 'Withering's Arrangement of British Plants,' published in 1818, was 564. In the 'Index Fungorum Britannicorum,' recently printed, there are enumerated 2,479 species. By far the greater num-

* 'Rust, Smut, Mildew, and Mould: an Introduction to the Study of Microscopic Fungi.' By M. C. Cooke. 12mo. Hardwicke: London, 1865. 238 pp.

ber of the species thus added depend for their specific as well as their generic characters, upon microscopical examination. At the present day the British species of flowering plants scarcely exceeds three-fourths of the number of Fungi alone.

Mr. Cooke desires to turn the attention of lovers of science to these minute objects, and to induce them to apply their microscopes in tracing out their structure and mode of reproduction. He illustrates the organic forms and structure of numerous kinds of moulds, and gives coloured representations of them. He refers to the cluster-cups, spores, spermagones, sterigmata, stylospores, and other structures in Fungi, but he fails, we think, in making them intelligible to a mere beginner. The work seems to be rather fitted for one who has acquired preliminary information on the subject. There is a vast accumulation of interesting facts (not, however, always noticed in simple and clear language), and much that is fitted to arouse attention to the subject in hand.

Speaking of the Æcidium of the Goatsbeard, the author remarks:—"If we compute 2,000 cluster-cups as occurring on each leaf, and suppose each cup to contain 250,000 spores, we shall then have no less than five hundred millions of reproductive bodies on one leaf of the Goatsbeard (Tragopogon), to furnish a crop of parasites for the plants of the succeeding year." This gives some idea of the enormous production of germs in these plants. No wonder that they are diffused through the whole atmosphere, ready to fix their abode on any substance where they can find pabulum. The production of mould everywhere depends on the existence of these unseen microscopic germs in the air around us.

Fungi exhibit remarkable changes of form according to the element in which they grow. Hence the diversified forms assumed by Penicillium glaucum, and other kinds of mould when found growing at one time on trees, at another on animal tissues, and at another time on syrup. In speaking of Dimorphism in Fungi, Mr. Cooke points out that the same fungus often passes through two marked conditions—one being the imperfect and undeveloped, the other the fully developed state. "One plant, for instance, sprinkled over the under surface of a rose-leaf, like turmeric powder, has its mycelium or root-like threads (spawn) penetrating the tissue, whilst bearing above its spherical golden-coloured spores. Its vegetative system is complete, and apparently its reproductive also. Hence it seems to claim recognition as a perfect plant, and under the name of *Uredo Rosæ*, was so recognized, until microscopical investigation determined otherwise. Thus it has been discovered that certain dark-brown spots, which appear later in the season, are produced upon the same mycelium, and are indeed aggregations of more perfect and complex fruits of the same plant. Before this point was satisfactorily decided, the brown spores, which are borne on long stalks, and are themselves septate or divided by transverse partitions into a complex fruit, received the name of *Puccinia Rosæ*." Thus, two plants, which he thus referred to different genera, were found to be one and the same species in different conditions.

"One of the fungal diseases of corn, long and widely known, has obtained amongst agriculturalists different appellations, such as smut, dust-brand, bunt-ear, black-ball, and chimney-sweeper, all referring, more or less, to the blackish, soot-like dust with which the infected and abortive ears are covered. Wheat, barley, oats, rye, and many grasses are subject to its attacks. No one who has passed through a field of standing corn after its greenness has passed away, but before it is fully ripe, can have failed to notice, here and there, a spare, lean-looking ear completely blackened with a coating of minute dust, which comes off easily when touched. Every granule of this minute powder constitutes a spore capable of germination. One square inch of surface contains about 8,000,000 of these spores. The plant which yields this minute gem is the Ustilago segetum, or smut of the standing corn."

The work is rather deficient in lucid order. There is a want of a separate table of contents and of an alphabetical index. The arrangement of the whole work might be improved, and the facts might be so given as to lead a beginner from one step to another until he fully masters the subject. As it is, we fear that many a tyro will be unable to cope with the author, and, while he may carry away a great deal of useful information, yet he will not have acquired a solid standing in the study of Cryptogamic Fungi. The style of the writer is often involved and stiff, and wants the ease which is so essential in scientific treatises. The Appendix contains a classification and description of the Fungi contained in the volume, and an explanation of the Plates. The latter should have been inserted along with each plate in the volume, so as to be more easily consulted by the reader.

PAMPHLET.

For and Against Tobacco.*

The title of this Essay is greatly in its favour, for although enough has been written upon the use of Tobacco, it has all, since King James's well-known "counterblaste," been upon one side, and that the unpopular one; and for the most part it has been written in ignorance and prejudice. But we learn from the present paper that there is also something to be advanced in its favour, and Dr. Richardson's well-known ability, together with the fact that his research is based upon original observation, will cause his opinion upon the debated subject to be highly valued.

The products of the decomposition of tobacco in smoking are by no means constant, but the widest differences prevail arising from differing cigars, differing kinds of tobacco, and differing pipes, although some substances are common to all, as watery vapour, a

* 'For and Against Tobacco.' By Benj. W. Richardson, M.A., M.D. Churchill & Sons.

small portion of free carbon, ammonia, carbonic acid, and a peculiar compound oily product, consisting of a fluid alkaloidal body (nicotine), a volatile substance, and a dark resinous extract. Of these, nicotine is the last to exert any effect upon the smoker. The first impression of tobacco smoking is made upon the blood, which rapidly circulating, conveys it to the more vascular organs, and the stomach is the first to give indication of suffering, and there under ordinary circumstances the matter ends. If, however, it be continued beyond that point, the brain and nervous system next become affected; and, pushed farther, death ensues from arrest of the beating of the heart. Tobacco, however, is *not a narcotic*, nor has it any of the seducing effects of a narcotic at its first trial, but becomes milder as it grows more familiar, *a tolerance* being set up such as is the case with many other poisonous substances, as antimony, &c. The products of tobacco find a ready exit from the system, by the lungs, skin, and kidneys. Hence the ammoniacal breath of every heavy smoker, and the smell of the clothes, partly due to the vapour which is exhaled through the skin, while the nicotine and bitter extract are carried out entirely by the kidneys. The effects, therefore, are transitory, and the influences exerted are functional, not organic.

What, then, is the nature of these transitory functional disturbances of the blood, stomach, heart, nervous system, and glands of the throat and mouth? This subject next engages the author. He finds the blood thinner than natural, and in extreme cases, paler; the corpuscles lose their round shape and become oval and irregular, but rapidly recover their normal condition when the cause is removed, while free imbibition of fluid, during prolonged smoking, increases these derangements. Upon the stomach, the effect is to impair appetite by diminishing the oxidation of the body, and so preventing waste. The mucous membrane and the muscular layer are both affected, the former by the bitter extract, the latter by the nicotine. These substances both travel along the stem of the pipe, and are absorbed directly into the mouth, so that while a long, perfectly clean clay pipe, which easily absorbs them, may be smoked with impunity, only the confirmed smoker can tolerate the black, dirty bowl and stem, and in proportion as the toleration is borne, the digestion is sacrificed. So, also, some tobaccos, as cavendish, pigtail, and shag, yield these products much more abundantly than Latakia or Turkish, &c.; while cigars, if they are "good," produce dyspepsia very quickly; for in smoking them, unless a long mouthpiece be used, nicotine is inevitably absorbed. With regard to the heart, there is no evidence to show that tobacco causes any structural change, but Dr. Richardson is of opinion that in persons strongly disposed to rheumatism or gout, tobacco is rather a preventive of structural change, and also that in persons subjected to an unnatural degree of muscular exercise, a pipe daily is beneficial rather than otherwise. Moreover, tobacco has a tendency to counteract the serious organic diseases dependent upon the acid modifications of the blood due to excessive imbibition of alcohol.

The effects produced upon the eye appear to be dilatation of the pupil, and in extreme cases amaurosis, due to the absorption of

nicotine; upon the ear, confusion and inability to appreciate distinctly sounds that are either very soft or unusually loud; with occasional sharp ringing in the ears; and it is probable that after long smoking both smell and taste may, to a certain extent, be impaired; but the rule is not general, though snuff-taking does destroy the sense of smell. With regard to its effects upon the mental faculties, most contradictory statements have been made, it being too often inferred that because certain symptoms occur in persons that smoke, *therefore* those symptoms are due to the tobacco, and to nothing else. That it tends to produce insanity, without predisposition, Dr. Richardson firmly denies, and even where predisposition is present, he believes that the damages committed by tobacco are fully and even more than met by the advantages which occasionally follow. As a rule, the mischief produced upon the nervous system is transient and evanescent.

Can smoking excite locally—as in the lips, tongue, or throat—the disease cancer? To this the author replies that he has never met with a single instance in which tobacco smoke could be said to have brought on the acute disorder; and epithelial cancer of the lower lip appears to be due, not to the tobacco, but to the mode of smoking it—*viz.* in short pipes, which press habitually upon the lip. It does not become developed in cigar smokers, nor in those who smoke long smooth pipes.

Neither consumption nor chronic bronchitis can be produced primarily by smoking, but the indirect effects are harmful to those in whom the disease is developed, and the author insists on every consumptive patient yielding up the pipe or cigar, and has found a rigid adhesion to this rule worth many a formal prescription.

Dr. Richardson's essay is impartial and philosophic, his results often at variance with popular and established principles, which, however, have only imperfect information as their basis; and as is generally the case, a careful weighing of the evidence gives strong reason to believe that the use of tobacco is not wholly good, nor wholly bad; but that, at all events in our artificial mode of life, there are conditions in which the weed, by some despised, by some worshipped, may be of real service.

NOTES AND CORRESPONDENCE.

Reform in the Committee of Council on Education, and the Science and Art Department.

THE appearance in our last Number of the article on the Science and Art Department, has brought us many painful expressions of approval, both from the Press and from individuals who have suffered from the mismanagement at South Kensington. Newspapers have been forwarded to us from Exeter, Plymouth, Glasgow, &c., with articles complaining bitterly of the injury done to local institutions, and expressing a fervent hope that there might soon be Parliamentary interference in the matter.

From Science teachers, too, we have received communications — some conveying a desire to form a defensive association, others expressing fear lest such a movement might prejudice them still further with the State.

In one case, the friend of an ex-teacher forwards to us a statement of the history of the teacher's connection with the "Department." As it fairly represents the working of the whole system, and the teacher is well known to us by reputation, as one of the most successful (if not *the* most successful) of the whole body, we do not hesitate to publish it as received :—

"He began his courses of instruction in 1860; the money received by him as the result of that year's teaching was, in round numbers, 130*l*.; the next year it increased to 170*l*.; the year after to 230*l*.; and in 1863 to 250*l*. Then the influence of the Revised Code was felt; the result being that, with about the same number of pupils, of the same average capacity as those of former years, the teacher's earnings at once fell to 90*l*. He saw at once—in fact, he could not help seeing—that it was now utterly useless to expect to earn a livelihood by teaching Science under the auspices of the Committee of Council on Education, and although he had spent several of the best years of his life in qualifying himself for that work, he was reluctantly but imperiously compelled to relinquish the duties he had discharged so successfully."

This statement (which, as we have already observed, is typical of the working of the system, for we know other excellent men who have suffered in a similar manner) does not represent the whole hardship of the case, and delicacy for the feelings of scientific men, so little considered by the authorities at South Kensington, prevents us from publishing further details.

We must now wait patiently for the results of the inquiry into the "constitution and procedure of the Committee of Council on Education," undertaken by the Select Committee of the House of Commons, moved for and obtained by the Right Hon. Sir J. Pakington, and we have great confidence in the fairness of such an investigation; for, although it is impossible to guard against the introduction of abuses into any department of the State, and to prevent maladministration and an unwise employment of public moneys, we feel sure that, whenever a number of honourable English statesmen set themselves earnestly to work to correct an abuse which *has* been laid bare, they will not leave their work incomplete.

The "Select Committee" is, in this case, entitled to the cordial co-operation of every person connected with Science instruction in the three kingdoms, and we earnestly appeal to all persons who desire that the State should be at least as honourable in its dealings as are private

individuals, to lend the movement their utmost support.*

Sir John Pakington was right when he said that great dissatisfaction prevails throughout the country with the administration of that section of the Government which is supposed to consist of a number of cabinet ministers, but which is practically represented by two or three heads of departments, or more properly speaking Government officials. It is not Lord Palmerston, nor Mr. Gladstone, nor any other minister, who manages the Educational Department of the State — it is Mr. Lingen and Mr. Cole.

Of the former we know but little, excepting that he appears to be no greater favourite with the Science and Art Department than he is with the country. Of the latter we perhaps know a little more. He loves art, takes a great pride in the South Kensington Museum, upon which he is permitted to expend vast sums of money, which should, if the engagements of the State were honourably fulfilled, be paid to Science teachers for work done; and he is heard of by the committees and managers of Science schools about as frequently as they hear of the "Lord President." Nay, let us not be unjust to his lordship—not so often. During the last four or five years we have seen every protocol, and every "form," issued by the Department, and we never recollect to have observed the signature of Mr. Henry Cole to one of them. Sir John Pakington is right, then, when he says that there is no responsible head to the Education Department, and it is easy to conceive the confusion which must exist under such a state of things—the little fracas which must arise between the departments as to the disposal of the public funds. We have good cause for believing that, after the appearance of the Revised Educational Code, the Science and Art Department had to struggle with the Education Department for its very existence. It escaped being choked to death, but its life-blood is ebbing fast.

One of the speakers, on the motion for a select committee, stated that the inquiry now being instituted would merely have the effect of showing the excellent system of management adopted by the Committee of Council on Education, whilst another, holding similar views, remarked that it would simply cause persons with grievances to pour them into the ears of the committee. We can hardly reconcile one statement with the other, but doubtless the second will be found to be correct.

No doubt every means will be taken to make matters look as pleasant as possible in the happy families at South Kensington and Whitehall, but we trust that the loud complaints which will not fail to reach the committee will open their eyes, and cause them to enter upon a searching investigation of the actual state of the case. We hope that the Committees of Management, who not only work gratuitously themselves, but pay those persons whom they entrust with the central authority (a fact which seems to be quite overlooked by the officials in receipt of fat salaries)—we hope that these will come forward and lay a correct statement of the working of the various departments before the committee, and that they will petition for a reformed management of the whole section of the State. That it is their duty towards those whom they engaged, relying upon the good faith of Government, to do the work of Science teaching, there can be no doubt, and it is equally true that they owe this to the numerous young students upon whom they have hitherto been the means of conferring "a little knowledge," but who, under the present system, will soon be thrown entirely upon their own resources.

* The Select Committee consists of Sir John Pakington, Mr. Bruce, Mr. Walpole, Viscount Enfield, Lord Robert Cecil, Mr. William Edward Forster, Mr. Adderly, Mr. Clay, Mr. Howes, Sir Colman O'Loghlen, Mr. Walter, Mr. Thompson, Mr. Stirling, Mr. Buxton, and Mr. Liddell.

On the Connection between the supposed Inland Sea of the Sahara and the Glacial Epoch. By Rev. Horatio J. Ward, M.A.

A large number of our most eminent geologists appear to have given in their adhesion to the theory, that the Glacial Epoch was coincident with the period during which the Sahara of North Africa formed the bed of an ocean or vast inland sea. Many, I believe, consider further, that these physical conditions so different to existing ones, were not merely coincident, but were closely connected as cause and effect, that is to say, that the phenomena of the Glacial Epoch may (to a certain extent) be accounted for, by the fact of the existence during that epoch of an expanse of water, where now is to be found only one of sand.

It would be needless for me to dwell on the facts and reasons by which this theory is supported, for by this time they must be tolerably familiar to most of the readers of this periodical; but so far as I am acquainted with what has been written on the subject, only the *immediate* and *direct* influence which the former of these two physical states exerted on the climate and temperature of Southern, Western, and Central Europe has been touched upon; whereas it appears to me that the *in*direct influences must have been far greater and more widely felt.

It is upon these latter, then, that I wish to broach a few ideas, trusting that some of your wiser readers will enlighten me if I am wrong, or pursue the subject in your pages, if so far I should be found right.

My argument compels me to mention first, some well-known and common-place facts.

Everyone now-a-days is aware that the warm climate of Western and North-western Europe is owing to the Gulf Stream; but it is *not everyone* who knows what are the causes of this great current. Subsidiary causes there may be, but undoubtedly the main one is, the North-east trade-wind, blowing incessantly, and with considerable force, in the Atlantic from a few degrees north of the equator to about the 27th or 28th parallel. The effect of this steady pressure, all in one direction, over so enormous an expanse of water may be imagined by those who have at all paid any attention to such subjects: there is an abnormal elevation of the water on the North-east coast of South America, to the height of (I believe it has been calculated) thirty feet. Literally, we have the "Atlantic Steep," of Thackeray's well-known verse. This enormous accumulation of water streams off northwards, until, released from the pressure of the trade-wind, but still retaining its northern impetus, it trends to the North-east—towards our own shores, Iceland, and even Spitzbergen.

This slight outline will suffice to show how the N.E. trade-wind is the moving cause of the Gulf Stream; and now I hasten to the next link in the chain of cause and effect. What causes the N.E. trade-wind?

Most geographers, I believe, will reply without hesitation, "Mainly the Sahara," but let us see how. The air throughout the whole of the tropics being heated, and thus rarefied, ascends into the higher regions, and its place is supplied by the colder atmosphere streaming in from north and south. This simple statement, however, requires, of course, many modifications. I must confine myself to two immediately connected with our subject. The first is this. As the air streams in from the Arctic regions where the velocity of the earth on its axis is small, to the tropical regions where it is considerable, it is obvious that the motion of the earth from W. to E. being only *partially* communicated to the air, the latter will be left behind as it were—that is, there will be an apparent motion in it from E. to W.

in those parts of the earth's surface towards the equator. *North* of the Line, then, this westerly direction of the wind, combined with the southerly direction spoken of before, gives, (by the well-known mechanical principle of the parallelogram of forces,) as a resultant, a direction of the wind from the N.E., this is the trade-wind of the North Atlantic. But next, let it be observed, this wind owes almost all its force to the fact of the enormous radiation of heat from the surface of the Sahara, causing a prodigious rarefaction in the atmosphere above it—hence a vehement impetus is given to the current of air traversing it from the N.E.; that is to say to the wind, which, as we have seen by its action on the waters of the Atlantic, is the main cause of the Gulf Stream.

Suppose, then, the Sahara to be an expanse, not of *sand*, as now; but, as formerly, of *water;* what would be the results?

Much that of the old nursery story—"Water won't quench fire, fire won't burn stick," &c.—the trade-wind would cease, or be so reduced in strength as to exert but slight pressure on the surface of the Atlantic; then, as a consequence, the Gulf Stream would either cease or shrink into insignificant dimensions; the icebergs from Greenland, instead of being melted by the heated waters far towards the north, would encroach more and more southwards; the seas round our own islands, and (*à fortiori*) those more to the north, would again present the spectacle of an Arctic or sub-Arctic climate, at least as severe as that of Labrador in the same latitude: in short,

——"grave rediret
Sæculum,"

the phenomena of the Glacial Epoch would be renewed over the greater part of temperate Europe.

My letter is longer than I had intended it to be, though I have rather indicated than expressed many points of my reasoning, and have strictly avoided all collateral issues. May I venture to hope that some abler pen will take these up, and thoroughly ventilate the whole subject.

H. J. Ward.

Bridgnorth, 11*th March*, 1865.

The New South Wales Coal Fields. From Mr. John Mackenzie, Government Examiner of Coal Fields, New South Wales.*

Since I last wrote to you, and within six weeks, I have had two long and tedious exploring journeys. In the first trip, I rode in about ten days upwards of 300 miles over a very rugged country, going in one place over a barren sandstone country thirty-five miles in length. I left here with my man and three horses, one horse being the *pack horse*—that is, it carried the provisions, panakins, blankets, pick, saddle-bag, &c., and a piece of oilskin, with some calico stuffed with sea-weed for me to lie upon. I went for the purpose of seeing whether the *Hartley coal* seams in the county of Cork belonged to the same coal basin as Newcastle and Wollongong (*see* plan of New South Wales), and to see if I could find out with which known seams of coal on this side they were identical. I was able to recognize them. Another reason for my going was, that I had an idea that I could find coal identical with the Fitzroy coal at a distance of thirty miles from Sydney (the metropolis of New South Wales). The route

* This communication reaches us through the courtesy of a correspondent in England, to whom it is addressed (not to the Editors). Our readers will, we believe, be glad at all times to peruse similar authentic records of the progress of scientific discovery abroad.—*The Editors.*

by which I wanted to come and return home to satisfy myself if coal existed there, I was told was uninhabited, and that I could not find it without a guide; so I engaged a black fellow, and a tremendous journey we had of it. I have satisfied myself that coal will be there, but must examine another place before I can tell whether there is a good seam of coal. I have found the lower coal, which is inferior, and cannot yet tell whether it will be near enough from the edge of the coal basin for the next excellent seam of coal to come in above it. The coal *measures* I find gradually increase in their thickness from the edge of the coal basin towards the centre of it, and the Sydney or Clarkes Hawkesbury sandstone rests on the coal measures near the edge of the basin, whilst near the centre of it, it is 900 feet from the top, coal sandstone and shales of a different nature to the Hawkesbury sandstone intervening in the 900 feet; and it has always been supposed by other geologists that it would always be 900 to 1,000 feet from the Hawkesbury sandstone to the first coal, whilst I am certain that I can find it only thirty miles from Sydney at a depth of 150 to 200 feet; but if I go to twenty-eight miles, and find the top coal coming in, it might be 400 feet.

The last journey was one of the worst I ever had, and I am now suffering with a touch of rheumatism in my leg from it. The first day we went fifty miles on horseback in a hot wind, and the next day forty-five, arriving at Windsor. Went from there to Richmond, up the river Grouse, towards the boundary of the county of Cork. It is considered about one of the worst places in New South Wales to travel. We tried to take horses up it, but after cutting their feet, we sent all back but the pack-horse, and after going six miles up, we had to leave the pack-horse tied to a tree, take our provisions and a blanket, and crawl over and under logs, and jump from stone to stone. Well, about 7 P.M. that night, we lighted a fire in a most dismal and uncomfortable place, had our *beds* made of hard sandstone, with a few rushes and ferns cut and thrown over it, and a ledge of a rock to shelter us. The river having rocks on each side of it 500 to 600 feet high. To our horror, at 3 A.M. it commenced to rain, and we held a consultation whether we should go farther up the river to seek the coal, and dry our clothes at the fire at night, or return. Well, we decided to go on, and after going about four miles, which took us *five hours*, and finding the river getting more impassable, we thought we could not possibly get to the coal in one or two days; and as we were wet through to the skin, we decided to retrace our steps. When we reached the horse, we found that he had got frightened, and cut his knee; and when we came to take him home, we wondered how we had brought him so far, and thought he would have killed himself; and we have partly ruined him. It was very lucky for us that we just managed to get to a house when quite dark, or I should have had a worse touch of rheumatism than I now have. I little thought when I used to see the gipsies at Aspull Moor that I should ever go about in that way. I was going home when it cleared up, so I thought I would go up another river, which proved to be ten times worse than the previous one, and although we only went eight miles up it, and wished to return that way, we preferred walking forty miles round to going the eight miles to where we had left our horses. The man I had with me being an Irishman, and not used to such journeys, got very surly when he saw me going up different hills, and I had to give him a little of my mind about it; and the riding made him very sore. The day we were so wet, I was

ahead, and he kept calling out, "Hold; I am so wet, I can hardly walk."

You know what it is to walk under fern *trees* laden with rain.

I will just give you an outline of what I know from my own explorations of this vast coal-field.

I have explored the counties of Camden, Cumberland, Cork, Hunter, Northumberland, and Durham, and find that the New South Wales Coal Basin extends under the whole of them, and a portion or the whole of Gloucester (I have not explored the whole of it), a portion of the counties of Brisbane (*not Brisbane, Queensland*), Phillip, Roxburgh, Westmoreland, and St. Vincent, and that the south-easterly and north-easterly side of the coal basin lies partly buried under the Pacific Ocean, and principally washed away, which makes the New South Wales Coal Basin at least 200 miles in length, and probably the same in breadth; but the breadth can never be ascertained, owing to the easterly side of the basin being in the Pacific Ocean. I know this will interest you. * * * *

John Mackenzie.

On the Iron-bearing Deposits of Oxfordshire. By E. Hull, B.A., F.G.S.

It is not very generally known that there are considerable tracts of iron-bearing deposits in Oxfordshire, which, when this generation shall have passed away, may be the means of converting this rural and quiet district into a second Middlesborough. This we say advisedly, for, with some geographical differences which will occur at once to every mind, the geological and mineral features of the two regions are similar. Middlesborough and Teeside generally, have advantages in their proximity to the coast for export trade; in being less distant than Oxfordshire from the coal districts, and in having less competition with iron ores from the coal districts of the north of England themselves. For the present, therefore, and for many years to come, the favoured region of Cleveland must hold its own; but it is well to know that when the process of exhaustion in this and other centres of production shall have been completed, other regions are lying in wait to step in and recruit the ranks of trade.

It is time, however, to come to the subject of the geological age and mineral character of the Oxfordshire ores. Strictly speaking, there are three iron-bearing formations in Oxfordshire, but only one of any importance whatever. The highest of these, in the geological scale, are the silicious ores of the Wealden—or Lower Greensand formation (for it is doubtful to which of these groups the beds belong), which are found on the highest parts of Shotover Hill, near Oxford. Here there is a considerable quantity of dark silicious ore, apparently tolerably rich, and only made use of for building walls and similar work. The limited extent of this rock, and its inaccessible position (speaking commercially), render it of no intrinsic value, and only to be treated with consideration from the fact that it contains, in some places, a remarkable group of fresh-water shells.

The next iron-bearing formation in descending order is the Great-Oolite. The basement beds of this formation, when traced from Oxfordshire into Northamptonshire, are found to become gradually more and more silicious, and eventually merge into the "Northampton sands." These yellowish sands (which stratigraphically represent the Stonesfield slate series, a "lower zone of the Great Oolite") become, in certain places, calcareous; in others, ferruginous; and thus pro-

duce, both in Oxfordshire and Northamptonshire, a silicious iron ore capable of being worked. In the former county, however, we only know of one spot where it is of any commercial value—we refer to the village of Steeple Aston, near Deddington; but even here we should infer, from the character of the ore, that it would be capable of producing only exceedingly brittle iron. Having thus briefly disposed of these unimportant ores, we now proceed to the third, and the only commercially valuable iron ore in Oxfordshire—this is the rock of the Middle Lias, or Marlstone.

This remarkably persistent rock, extending as it does from the south coast of England, through Somersetshire, Gloucestershire, Oxon, and Northamptonshire, to the Yorkshire coast, though never of greater thickness than twenty or twenty-five feet, and often less than a third of that amount—is, in certain places, a calcareous sandstone; in others, a valuable ironstone. Under the former character, it may be traced along the western flanks of the Cotteswold range of Somersetshire and Gloucestershire, often jutting out from the sides of the hills in the form of terraced or tabulated banks, subsidiary to the main ridge. In this district, however, it is never an ironstone, but a highly calcareous sandstone, crowded with characteristic fossil shells. On being traced, however, into Oxfordshire and the neighbouring districts to the north-eastward, it becomes more or less impregnated with iron, till it assumes the character of a nidious peroxide or carbonate, with a proportion of metal varying from 20 to 40 per cent. The rock rests generally on certain sandy shales, more or less pervious to water; and is surmounted by the blue clays and shales of the Upper Lias, which separate it from the Great Oolite. The thickness of these shales varies from 20 feet at Fawler, near Charlbury, to about 120 feet in the neighbourhood of Banbury, and they often form sloping grassy banks, rising above the terraced surfaces of the Marlstone rock. In the Cleveland hills, the iron-bed occupies a precisely similar geological position, underlying the blue shales of the Upper Lias, which are about 150 feet in thickness, and are in turn surmounted by the freestone of the Great Oolite, which forms the crest of the hills.

In both districts the mineral character of the ore is very similar. In the hills overlooking the estuary of the Tees, the ore, when hewn fresh from the interior of the hill, is of a greyish-green colour, and very solid, but gradually passes, on approaching the surface, into a rusty and somewhat concretionary stone, due to oxidation and weathering. In Oxfordshire, the rock assumes a deep olive-green colour, and under the lens, shows an Oolitic structure; on exposure, and at the surface, it also becomes rusty and somewhat concretionary; and in both cases, when calcined, it assumes a red colour resembling earthy hæmatite. In the Cleveland hills, however, the ironstone rock appears to be more persistent and uniform in mineral character than in Oxfordshire.

The ore occurs, and was first discovered at Fawler, near Charlbury, about six years ago, on the property of the Duke of Marlborough, along the line of the West Midland Railway. Considerable quantities have been sent into South Staffordshire, but owing to the depressed state of the iron trade, it is not, we believe, being worked at present. The rock is here about 12 or 15 feet in thickness, nearly uniform in character throughout; but in some places somewhat calcareous. An analysis made by Dr. Percy, at the Museum of Practical Geology, gave an average from nine samples of 32 per cent. of iron, and of phosphoric acid only a trace. For flux-

ing it requires 10 cwt. of limestone to the ton of iron, and taking the price of coke laid down on the spot at 15*s*. per ton, it has been estimated that the cost of smelting pigs, including royalties, labour, &c., would be about 2*l*. 12*s*. The carriage into South Staffordshire would be, in addition to the above, 3*s*. per ton.

A more extensive district, and one which also possesses the advantage of yielding the ore over a large surface without any cover, occurs to the west and south of Banbury, extending as far as the village of Hook Norton. Railways are already projected over this tract, occupying an area of perhaps 25 square miles; and visions of furnaces rising amidst the church steeples and farmsteads of this hitherto unsophisticated region are floating before the minds of some of the residents. For ourselves, we look upon this as reserve ground, not likely to be opened up for many years. But who shall venture to say what may or may not happen with the mines of the Cleveland hills, and furnaces of Teeside blazing away before our eyes, where all was silent and motionless a few years since?

E. Hull.

On the Occurrence of a Tertiary Species of Trigonia in Australia. By H. M. Jenkins, F.G.S.

The very interesting discovery of a species of *Trigonia* in the Tertiary deposits of Australia has in England remained entirely in the background, and I have been several times surprised at finding students of Tertiary palæontology, generally *au courant* with the progress of their special branch of science, unacquainted with the circumstance. Its importance, in a theoretical point of view, is beyond all question, hence the deep interest always exhibited by those to whom I have spoken on the subject. I trust that it will also justify my bringing forward in your Journal a subject not quite new, although very nearly unknown.

On the Southern Coast of Australia is a series of Tertiary deposits of vast extent, the exact age of which is somewhat doubtful. Certain portions are said to be older than others, but their palæontology has not been sufficiently studied to enable one to speak very definitely on the probable correctness of this view. The older beds have been called Upper Eocene by Professor M'Coy, and the younger Lower Miocene. But an examination of a collection from the beds of Muddy Creek, sent over by the Rev. Julian E. Woods, and marked "Eocene," induced me to believe that the shells contained in the collection indicated a Miocene, or even later age (using the term Miocene conventionally), and were allied partly to the recent Philippine fauna, and partly to European Miocene species. There is great difficulty in correlating Tertiary deposits so far away with those of Europe; but as Dr. Duncan has since published an opinion very similar to that just stated, founded on the Corals and Echinoderms, and Professor Rupert Jones is also inclined to the same view, from an examination of the Foraminifera, I think we cannot be very far wrong. Hence we may consider the *Trigonia* to which I have referred as being doubtfully Miocene, perhaps newer, its age being well enough defined by the Austrian term Neogene, which includes both the Miocene and the Pliocene.

The newest species of *Trigonia*, with the exception of the recent

ones and that in question, occur in Cretaceous rocks. The genus is pre-eminently Jurassic, but extends upwards into the chalk. Everyone knows that the Jurassic Mammals are very nearly related to the Marsupials of Australia, and that this curious relation has been used by geological theorists, much as the unfortunate frog has been tortured by experimenting physiologists. It is also well known that the Jurassic facies of the Australian terrestrial fauna is strengthened by the existence of three or four species or varieties of *Trigonia* in the neighbouring seas. But matters seem to have reached a climax, now that in the Tertiary beds of the same great island there has been found a *Trigonia* which is much more nearly related to the Oolitic than to the recent species, for it belongs to the same type as the former, and to a different one than the latter.

The recent species have radiating ribs commencing at the umbo, and proceeding straight to the margin; they belong to the "pectinate" division of the genus, and indeed entirely constitute it. The Tertiary species, which has received the name of *T. subundulata* from Professor M'Coy, though it has never been described, belongs to the "costate" group, which is mainly represented in Jurassic rocks, but a few species of which pass up into Cretaceous strata. The chief characteristic of this group is that the anterior portion of the shell is ornamented by longitudinal ribs, which stop short where they meet the keel, extending from the umbo to the lowermost of the three posterior angles, from which the genus derives its name; behind this the ribs are nearly vertical, that is to say, parallel to the keel, and nearly at right angles to the longitudinal ribs already mentioned. In this chief feature *Trigonia subundulata* resembles all the species of the "costate" section, coming nearest, perhaps, to *Trigonia suprajurensis*, Agass.; but it should be mentioned that the keel is not so prominent as in other "costate" species, being scarcely more so than the rest of the ribs.

Every palæontologist believes that, when a genus of animals is represented by species occurring in strata of widely different ages, it must have been perpetuated by some one or more species during the whole of the intervening period. In fact, it is generally assumed that a genus or a species never reappears after it has once died out, and palæontologists feel as certain of the truth of this postulate as of that of the first axiom in Euclid. The same law would generally be allowed to hold as good for families, orders, and classes, as for speeies and genera.

It seems paradoxical that the most ardent admirers of the "final cause" line of argument, as opposed to the empirical, should be the most strongly opposed to an application of their practice to this curious subject; but such appears to be the case. The reason is obvious. The only rational *meaning* that has ever been attached to this presumed general law (for it is incapable of proof in many cases) is, that the perpetuation of the genus, species, family, &c., as the case may be, has been due to "descent with modification." The accident of the intermediate links being unknown in such cases, when everyone believes them to have existed, supplies an excellent parallel to the frequent absence of the fossil remains of the "connecting links" between groups of animals, especially as this absence has so frequently been a stumbling-block in the path of the students of Mr. Darwin's theory. The absence in the one case appears to be due to the same causes as in the other; and if the want of evidence be not incompatible with former existence in the former, neither is it in the latter.

Trigonia subundulata is one of the links hitherto wanting; first, in ex-

planation of the existence of the genus *Trigonia* in the Australian seas of the present day; and secondly, as showing that the great gap which before existed in its life-history was no proof of the falsity of the postulate of palæontology to which I have referred, but was simply a consequence of the imperfection of our knowledge of the geological record; for, though the record itself is imperfect enough, our knowledge of it is still more so. The discovery of this *Trigonia* also gives strength to the comparison of the recent Australian fauna with that of the Jurassic period in Europe, and supplies those who do not believe in the exact synchronism of distant formations containing similar fossils, with an excellent illustration of their views.

Books received for Review.

From *The Smithsonian Institution, Washington*:—

Bibliography of North American Conchology, previous to the year 1860. By W. G. Binney. Part I. American Authors. Part II. Foreign Authors.

Results of Meteorological Observations made under the direction of the United States Patent Office and the Smithsonian Institution, from the year 1854 to 1859 inclusive: being a Report of the Commissioner of Patents, made at the first Session of the 36th Congress. Vol. II. Part 1. Washington: Government Printing Office, 1864.

Monographs of the Bats of North America. By H. Allen, M.D., Assistant Surgeon, U.S.A. Woodcuts.

The Gray Substance of the Medulla Oblongata and Trapezium. By John Dean, M.D. 15 Photo-lithographs and Copperplate Engravings. 4to.

Researches upon the Anatomy and Physiology of Respiration in the Chelonia. By S. Weir Mitchell, M.D., and George R. Morehouse, M.D. Woodcuts.

Records and Results of a Magnetic Survey of Pennsylvania and Parts of Adjacent States in 1840 and 1841, with some additional records and results of 1834–5, 1843, and 1862. And a Map. By A. D. Bache, LL.D., F.R.S., &c., &c.

Discussion of the Magnetic and Meteorological Observations made at the Gerard College Observatory, Philadelphia, 1840 to 1845 inclusive. Second Section. Ditto, ditto, Third Section. Same Author.

Meteorological Observations in the Arctic Seas. By Sir Leopold McClintock, R.N., made on board the Arctic searching yacht 'Fox,' in Baffin's Bay and Prince Regent's Inlet, in 1857-8-9. Reduced and Discussed by Charles A. Schott, Ass. U.S. Coast Survey. Map and Woodcuts.

Ancient Mining on the Shores of Lake Superior. By Charles Whitterley.

On the Construction of a Silvered Glass Telescope Fifteen-and-a-half Inches in Aperture, and its Use in Celestial Photography. By Henry Draper, M.D., Professor of Natural Science in the University of New York. Woodcuts.

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Instructions for Research relative to the Ethnology and Philology of America. By George Gibbs. (Smithsonian Institution, Washington.)

Address of the President of the Royal Astronomical Society, for the year 1864-5, Warren De la Rue, Esq.

Address of the President of the Entomological Society of London, for the year 1864-5, F. P. Pascoe, Esq.

A Companion to the Weather-Glass, designed to record, numerically and graphically, the Natural Phenomena presented by the Barometer, Thermometer, Rain-Gauge, Clouds, Wind, &c. With a Calendar for the year 1865. By a Meteorological Student. With Plates and Engravings. 70 pp. Post 8vo. (Bemrose & Sons.)

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BULLETIN MENSUEL DE LA SOCIÉTÉ IMPÉRIALE ZOOLOGIQUE D'ACCLIMATATION. (Masson, Paris.)

SMITHSONIAN REPORT, 1863; showing the Operations, Expenditures, and Conditions of the Institution for the year 1862.

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JULY, 1865.

ORIGINAL ARTICLES.

THE PLANET MARS.

By John Phillips, M.A., Oxon.; LL.D., Dublin; F.R.S.

The ideas formed of the heavenly bodies and the spaces in which they move, or seem to move, change from age to age, with the improvement of the means of observation, and from region to region, according to clearness of sky, advantageous situation, and favourable climate. Among all people, and in every age, the two great lights of heaven, the giver of day and the ruler of night, have been honoured, if not worshipped, as glorious emblems of the infinite power which governs the phases of Nature, "constant in her ceaseless change." The "starry host," contemplated by shepherds who watched their flocks by night on the plains of the East, very soon parted itself into the lights which seemed to be fixed and immovable in the blue revolving dome, and the "planets," or wanderers, which moved among the rest, and sometimes retraced their steps. To these also, as emblems of a guiding power, honour and worship were addressed; sacred names were given to them—days were named after them; and our Christian week preserves the titles of an earlier and alien creed.

The early Greek pilot who lifted anchor and set sail in the evening—as when Odysseus quits the shores of Phæacia, or his son leaves Ithaca for the mainland—turned for guidance to the stars which circled round the pole. Sitting sleepless by the rudder he observed the Pleiads and Bootes late sinking in the west, and the Bear who, continually revolving, watches Orion, without ever touching the sea.* The five planets observed were soon distinguished into those of longer and shorter periods; Saturn, Jupiter, Mars, Venus, Mercury; and to them the mystical relation was adapted which represented the slowest of the planets as the oldest and dullest, and gave to the quickest the name

* 'Odyssey,' lib. v. 271.

of the youngest and most sprightly, and dedicated the "fairest of stars" to the goddess of beauty. Looking back on these memorial names, and the ideas connected with them, from our present standpoint of augmented knowledge and lessened reverence, it is easy to believe that among the bards of antiquity, as among the poets of our own time, the standard of astronomical knowledge was below the philosophic level of their age. Yet Lucretius shows no such confusion of thought as occurs in the glittering verses of Pope, who transforms the simple Homeric simile—

> " —— as when in heaven the stars
> Around the shining moon look beautiful;" *

into the gaudy—

> "Around her throne the vivid *planets* roll
> And stars unnumbered gild the glowing pole."

Coming to modern times, when the Earth took her place in astronomical systems as one of the planets moving round a central sun, the idea of a common origin for the whole manifests itself in different ways: one general direction of their motions nearly in one general plane; one law of their periods; analogies of figure, of rotation, of borrowed light, of attendant satellites; all concurred to justify the supposition of the planets possessing one common character of constitution, adaptation, and use. Not that those ideas of common origin and similar composition are to be found clearly traced out by the immediate followers of Copernicus, though Kepler furnished the planets with inhabitants, and Brunus and Cusanus allowed the sun and fixed stars theirs too. Not even among the contemporaries of Newton was there enough of acquired knowledge in regard to many of the phenomena to suggest a really general speculation as to the beginning of the solar system. The argument from analogy and the fitness of things, was indeed strongly felt and strongly urged in the seventeenth century, so that, to take no other example, Christian Huygens, writing to his brother Constantine, said:—"A man that is of Copernicus's opinion, that this earth of ours is a planet carried round and enlightened by the sun, like the rest of the planets, cannot but sometimes think that it's not improbable that the rest of the planets have their dress and furniture, and perhaps their inhabitants too, as well as this earth of ours, especially if he considers the later discoveries made in the heavens since Copernicus's time, *viz.* the attendants of Jupiter and Saturn, and the champaign and hilly countries of the moon, which are a strong argument of a relation and kin between our earth and them, as well as a proof of the truth of that system."†

Huygens, it is well known, bestowed great attention on Saturn and his rich retinue of rings and moons. Speaking of Cassini's observations with long telescopes, by which the inner satellites of that system were discovered, he in some degree anticipates by nearly a century the thoughts of Bode and Olbers, when declaring his expec-

* Ὡς δ' ὅτ' εν ουρανῳ αστρα φαεινην αμφι σεληνην—φαινετ' αριπρεπεα.

† 'Celestial Worlds,' Ed. ii. English translation, 1722. The work was first issued after the death of the author in 1684.

tation that by reason of the "disproportionately large distance" between the fourth and fifth satellites, a sixth might be expected there. Bode's law, dating from 1772, does, indeed, place in strong light the simple numerical proportions which prevail among the planetary spaces; and Olbers's discovery of the first of the small planets which occupy the interval between Mars and Jupiter, and thus confirm the law, adds much to the analogies which are the usual basis for the conviction now so general of the common origin of all parts of the solar system. What that common origin was has been sketched for us on quite opposite plans by two eminent Frenchmen, Buffon and Laplace.

In the mind of the Count de Buffon, such a speculation assumed a singular form. The matter of the planets was projected from the sun by the shock of a comet. It was quite fluid, and gathered by attraction, into globes rotating on their axes. In some cases, the rapid rotation of planets while still fluid, caused parts to separate and to collect into smaller globes, which circulated round the planets, as these revolved round the sun. During the cooling, which Buffon seems to have thought was pretty quick, the solid, liquid, and gaseous matters were separated, and took their places according to gravity. Most of the leading harmonies of the solar system are left unexplained, others contradicted by this hypothesis.

Laplace, who has honoured the scheme of Buffon by a notice of its inherent defects, attempted to rise to the true theory on sounder principles. He proposed what is now called the Nebular Hypothesis, on the fundamental idea of an original expansion by heat of all the substance of the planets into a vast atmosphere round the sun. Revolving round the sun, and subject to continual contraction by cooling, the external sheaths of this atmosphere would be left behind to continue their acquired movements, and finally to collapse into globes, rotating and revolving according to the one original direction. In a general sense, we may say the main facts of the solar system are not opposed to this speculation. The small excentricity of planetary orbits; their common direction of motion; the greater velocity of the inner planets; the various directions and great excentricity of comets; the zodiacal light; the nebulæ, which actually exist in a variety of forms; and, finally, the agreement of all the planets in their borrowed light, their spheroidal figures acquired by revolution, the presence of atmospheres, and the limited range of their densities—the larger planets being, in general, least dense—all these circumstances are apparently in harmony with this, the only general speculation at all supported by mathematicians and astronomers. To change it into an established theory by comparing it strictly with special phenomena of the solar system, such as the inclinations of the axes of planets, the order of their densities, the velocity of their rotations, the peculiarities of their satellites, has been hardly attempted, except in respect of the equality of the mean motions of rotation and revolution of the moon and other satellites, by Professor Haughton.* This

* 'Trans. R. I. Academy.'

remarkable adjustment appears not to be explained by the hypothesis, but not to offer a positive contradiction to it.

The orbit of Mars is more excentric than that of any of the other planets except Mercury: his distance from the sun varies from about 154 to about 130 millions of miles, the mean being about 140 millions. The earth being about 93 millions from the sun, the interval between us and Mars varies from about 40 millions at the least to about 240 at the most. The apparent magnitude of the planet as seen from the earth is sometimes as little as four seconds of space, and sometimes as great as twenty-two seconds.

When Mars is in opposition, that is to say, on the same side of the sun, and nearly in the same straight line as the earth, the best opportunity is afforded for telescopic observation. Mars revolves round the sun in 687 days, the earth in 365; consequently once in two years and seven weeks, roughly speaking, Mars is in opposition. As the points of opposition thus circle round the ecliptic, the declinations of the planet vary. Thus oppositions are more or less favourable, as the distance of Mars is less and his declination more to the northward. In 1862 Mars was in opposition on the 9th of October, in 1864 on the 30th of November; in the former case he was nearer to us, and had a visible diameter of 22″; in the latter he was farther off, having only a diameter of 16″, but his declination was more to the northward, and on this account he was well seen.

No occasion so favourable for observing the planet in opposition has occurred since 1836, or will occur again for twelve or fourteen years to come; but every opportunity should be seized of watching every change of appearance; for by reason of the considerable angle between the equator of Mars and the plane of his orbit, the planet is presented in various aspects; at one time the north pole, at another the south pole is more visible, while at particular epochs the axis is at right angles to the line of sight. Hence the extremely diverse and at first view perplexing appearances, which have been faithfully portrayed by Mädler, Herschel, De la Rue, and other observers.

The telescopes employed by Galileo were powerful enough to detect the phases of Mars; those in the hands of his successors revealed the more considerable spots. Hooke and Campanus were among the first to observe them, and Cassini, as might be expected from so great an astronomer, employed them in determining the daily period of rotation, which he found to be a little longer than that of the earth, *viz.* 24h. 40m., a result which differs (by excess) only 2m. 38s. from the period now generally recognized. Cassini's nephew, Maraldi, repeated these observations in 1704, and found the rotation to be 24h. 39m.; Herschel in 1784 assigned to this same period 24h. 39m. 21s.·67. These nearly agreeing determinations assure us, among other things, of the goodness of the long refractors employed in the seventeenth century before the introduction of achromatic telescopes. By observations of the same kind the inclination of the axis of the planet to the plane of its orbit is ascertained to be about 61° 18′, or, to use the ordinary expression, the obliquity of his ecliptic is 28° 42′. This ecliptic of Mars is oblique to the earth's orbit, 1° 51′. When in

1862 the opposition of Mars drew near, one of the first objects, with many observers, was to estimate the difference of his polar and equatorial diameters, in fact, to measure his ellipticity. The compression due to his rotation is very small, not greater than that of the earth, about $\frac{1}{300}$th. Now as the diameter of Mars is about 4,000 miles, and the difference of the diameters would be about 13 miles, and as the apparent diameter of the planet was nearly 22″, it is obvious that the compression would be $\frac{22}{300}$ or $\frac{1}{14}$ of a second; a quantity too small to be observable with certainty by any but the finest instruments. Our observations with the ordinary position micrometer failed to determine any sure difference of the diameters; and this is perhaps the most general conclusion of other late observers. Yet there is the high authority of Mr. Main, and a large discussion of measures with the famous Oxford heliometer for assuming the compression to be not less than $\frac{1}{37}$th. Arago had previously stated it at $\frac{1}{39}$th. Herschel indeed stated it at $\frac{1}{16}$th, but this was probably some accidental error. At the time of the opposition, the south pole of Mars was visible from the earth, the axis being then tilted toward the observer about 25½.

Around this south pole there was seen a coronet of bright, nay, splendid and glittering snow, elliptical in figure, and rather unsymmetrical to the axis. This mass of snow had been observed by Lord Rosse in July, three months before the opposition, and was then estimated to have a diameter of 1,000 miles; at the beginning of the opposition in October it was estimated again not to exceed 560 miles; it diminished sensibly and continually during two months of observation. The north pole was not visible, nor was any snow positively remarked in that region by any observer.

From this it appears that snows which surrounded the south pole to a distance of 16 degrees or to S. lat. 74° in the month of July, had retreated to about 8° or S. lat. 82° in the month of October, the pole having been all that time in sunshine. In 1864 the opposition was later in the year by about seven weeks (end of November). The south pole was tilted towards the observer only about 6°, and the snows had undergone the longer action of the sunshine. Accordingly it was only a very small ellipse of snow which could be detected, and that not always by the most careful observer round that only just visible pole.

On the other hand there were sure indications of snows in two situations very brilliant and prominent on the northern surfaces whose places, as represented on a drawing, have been transferred to the accompanying chart. These northern snows then appeared to reach a latitude of about 50°, and to constitute an interrupted arctic zone in the latter part of the south Martial summer, and towards the close of the north Martial winter. At this epoch then, not less than 50° of northern latitude were free from at least great tracts of snow, a result which fairly matches the average climate of the northern zones of the earth towards the end of our winter quarter in the month of February. In April, 1856, a careful drawing made by De la Rue,* represents two

* See 'Quarterly Journal of Science,' No. vi. p. 232.

snow masses, seen contemporaneously, one extended far around, or rather in one direction from the south pole, the other near, but not at the north pole, which was then presented to the sun. The snows near the south pole must then have reached to the 40th degree south latitude along one meridian. The interval between the snow of the north and the south appears to have been about 105°; while this interval on the earth may be taken at 120°, so that the temperature of the surface of Mars is not much lower than that of the earth, and perhaps is not subject to such extremes of heat and cold, though this could hardly be expected, since its revolution period is longer and its ecliptic more oblique than in the earth. The surface of Mars, which is generally free from snow, offers a great variety of distinct outline, which separates bright parts from dusky or shady parts. In general a very distinct, undulated outline of this kind can be traced along the inter-tropical regions mostly south of the equator, from which a large tract of bright surface spreads towards the north, while towards the south for the most part, the surface is either distinctly greenish grey, or appears in half lighted spaces, with less defined outlines than that already referred to. Calling the grey parts sea, and the bright parts land, the first impression on looking at Mars would generally be that water prevails in the southern, and land in the northern hemisphere. The land where broadest has a soft reddish tint, which resembles the hue common in low "cumulus" clouds in the morning and evening hours, or the diffused air tints in a foggy sunset.* Faint Indian red is a good imitation. This colour of the surface fades away in mere brightness towards the main southern boundary already referred to, and is hardly to be traced at all over any part of the smaller, and less distinctly bordered lands to the south. The white brightness of the land along the main boundary is occasionally so great, as in the meridian of 360°, as to suggest at first the idea of snows, but a careful inspection removes this impression. The brightness is in some degree enhanced in its effect on the eye, by the dark spaces which lie in the grey tracts on the south side of the boundary. This is observable in several parts, as represented in the chart, one broad dark surface appearing about the equator in long. 20°, and thence spreading with ramifications to the southward, and extending down a narrow channel (180 miles wide) towards the north polar region, which is apparently for the most part a watery surface; excepting these instances the dusky spaces are not strongly marked, nor, except in broad surfaces, is the greenish hue remarkable. Indeed, during the opposition of 1862, several observers with achromatics did not notice either the reddish tint of the land, or the greenish tint of the water, but both were always seen when reflectors were used.

It may now be fairly asked, whether the tracts of bright white surface called snows are such; the ruddy and bright surfaces really land; the grey shady spaces actually sea? Whether all the lighter

* Huygens noticed this and thought the land in Mars to be of "a blacker colour than that of Jupiter or the moon, which is the reason of his appearing of a copper colour and his reflecting a weaker light than is proportional to his distance from the sun."

tracts be, in fact, anything more than the appearances naturally arising from vast and diversified clouds shining above a dark surface, such as the brighter belts of Jupiter are thought to be?

In answer to this, it is to be remarked, that in respect of the snow there is proof of its gathering in the winter, and melting away during the summer and autumn; distinctly melting away almost under the eyes of Lord Rosse, Mr. Nasmyth, and others possessed of fine telescopes. There must then be watery surfaces, and an atmosphere capable of transporting vapour from one side of the globe of Mars to the other. Either the grey or the ruddy surfaces must be water. We can have little doubt which. Water must necessarily show much more obscure than the land, as any one may satisfy himself, who from a very high mountain will but look down upon the earth.* The white and reddish parts must then be land, and we are the more assured of this when we perceive it is over these parts the snow appears to spread far from the poles in the wintry seasons. Another doubt which may be felt as to the certainty of the boundaries drawn between the land and sea deserves careful attention.

For if we admit a vaporous atmosphere to Mars, how can we be sure of clear spaces in this envelope through which to behold—

"Oceans or mountains on the spotty globe?"

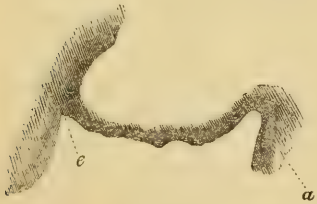
The true answer appears to be that we are really looking through an atmosphere partly clouded, as the earth's atmosphere is, and yet that this does not prevent our tracing the true boundaries of the land and sea if we observe often enough and compare the observations of different persons, made at different times, and under different aspects of the planet. It may sometimes confuse particular parts—some parts more especially and more frequently, perhaps—but on the whole there is no reason to expect more than this effect. For if we consider the spaces occupied by the clouds above the earth, we shall be sure that at any one moment of time the greater part of our sea coasts would be traceable by light and shade, while over some tracts vapours would hang in patches, and above others they would spread so as quite to conceal the surface of the land and sea. Even in this last assumed case of a wide-spread cloudiness, the observations of one day or week may be amended on another occasion. This, in fact, has been noticed by several observers, and one case in particular may be quoted. On our chart, in long. 45° and north lat. 15°, is the end of a sort of inlet from the great Meridional strait, which was seen in 1862 by Mr. Lockyer, and by Mr. Dawes in 1864. I did not see it on either occasion, nor did Mr. Lockyer see it always; yet it was seen by Mädler in 1836, and it must be admitted as a real feature in the hydrography. One second of angle included a space of about 180 miles on Mars during the former opposition, and 240 miles in the latter. If we grant that the eye could distinguish spaces to the minuteness of $\frac{1}{10}$ of a second, and that we were looking through a partially clouded atmosphere, it is almost certain that in general the

* Huygens' 'Celestial Worlds.'

cloudy spaces would not be distinguished as such, except by the general weakening of the distinctness of the outline between land and sea, which yet would remain traceable in all its main features. This effect has been occasionally experienced by every observer of Mars; never by any observer of the moon. Perhaps it is to some effect of this kind that the comparative indistinctness of the outlines, and indeed uncertainty as to the separation of the masses of land and water in the southern parts of the planet, is to be ascribed.

This uncertainty has been felt most in regard to the tracts of half-lighted land spreading southward between longitudes 240° and 350°; tracts which in our drawing are partially shaded, to imply some remaining doubt as to their being really land. A similar method has been followed in regard to the extended tract about long. 90°, 120°, and 150°, and lat. 40° south. In some drawings from Lord Rosse's telescope, in 1862, examples of extremely different aspects of the same part of the surface appear. About the central longitudes in the chart on the 22nd July, 1862, a very broad belt of light and shade swept excentrically round the south pole; the same tract, on November 6th, more resembled a very large network, and on the 6th of October it was still quite different, but resembled a drawing of Mr. Lockyer's, taken October 3rd. From the same great telescope, also, two drawings were made on the 16th September and 29th October, which differ much from each other, and from a drawing by Mr. Lockyer, 17th September, in the space south of the equator, about longitude 240°–280°. One of these drawings, September 16th, suggests, by its half-circular lights and shades, the idea of a vast cyclonic movement. A kind of enormous spirality also occurs in Mr. Lockyer's sketches for October 3rd, suggestive more of atmospheric vicissitude than terrestrial feature.

Adopting this idea of a great change of appearance over particular tracts due to atmospheric variations, we shall find the diversity of aspect from day to day between one observer and another, and between one telescope and another, less perplexing.



A remarkable dark spot on the equator, in long. 300° of our chart, was observed by Mädler, and has been often seen by other and later observers. It appears sometimes detached, as in our chart; at other times, connected with the long dark gulf, which extends to long. 360°. The whole of this gulf is found to change appearances in detail, yet not so as to render in the least degree doubtful the recognition of its main features. The sketches opposite will illustrate this:

On the whole then, the circumstances already collected regarding the physical aspect of Mars appear to justify the conclusion, that the planet has a larger proportion of land than water, in this respect differing from the earth, and that the land is mostly collected in a broad band, including the intertropical spaces, and the north temperate region, while broad seas encircle the north pole and a large proportion of the south temperate zone. In this last-mentioned large space, the appearances vary much, and in such a manner, as to indicate the overspreading of clouds, which reflect much light, and leave visible between their vaporous masses, the darker surface of the sea. Some particular limited tracts, of sea channel apparently, much darker than the rest of the surface, may, perhaps, derive this hue from greater depth of water. We are thus placed by telescopic observation in front of a planet, whose main characters of surface correspond to those of our earth; which has nearly the same density; nearly the same daily and nightly period; and is enveloped like our earth, by an atmosphere partially loaded with scattered clouds. It has also a character of climate not much different from the more continental parts of our globe, with which, on account of the excess of land over water in Mars it may be most fairly compared. How is this character of climate obtained by Mars, while the mean quantity of sunshine falling on any particular tract is only $(\frac{100}{152})^2$ of that which reaches and warms the earth? Only two suppositions can be at all worthy consideration: the flow of heat from the interior of Mars may be greater than in the earth, and the waste of heat from the surface may be much less. These may co-exist; but the most important, beyond any doubt, is the second. The waste of heat from the earth's surface would be enormously greater, and very much more rapid, than it is, but for the atmosphere, which acts in two ways to prevent it. First, it acts like a coating to a steam-pipe—the more of it the greater the effect. A greater depth of atmosphere round the earth would keep it very much warmer. If we suppose the effect to be proportional to the density (or pressure), then twice as deep an atmosphere as that which exists round the earth would sensibly raise the temperature, and in the same way the same effect would be produced in Mars. Again, the atmosphere has a specific action of this kind—it permits the solar light and heat to pass to the earth, yet by reason of its peculiar constitution, especially by the aqueous vapour and watery particles suspended in it, obstructs the radiation of heat from the earth. If, then, we suppose the atmosphere of Mars to be deeper than that of the earth, the waste of heat will be less.* It cannot contain more aqueous vapour, in proportion, than the earth, unless there be warmer oceans on Mars, for its marine area is less; but with a greater depth of atmosphere the

* "If we allow to Mars an atmosphere similar to that of the earth, but of greater thickness, to the amount of some 15,000 or 20,000 feet, the mean temperature may be 60° Fahr. at the equator and about 14° or 15° Fahr. at the pole, supposing the additional atmosphere to have rather less effect at the pole than at the equator."—*Hopkins in 'Camb. Phil. Trans.'* 1855, p. 663.

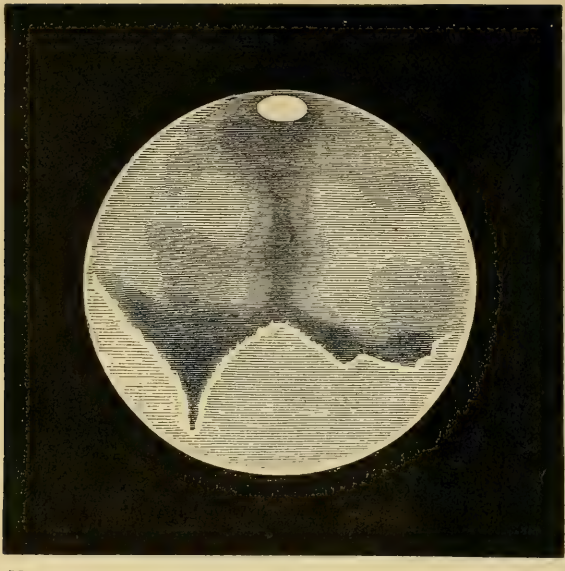


Fig. 1.—Mars as seen on the 27th of September, 1862, and on several other occasions till the 13th December. Longitude 0°.

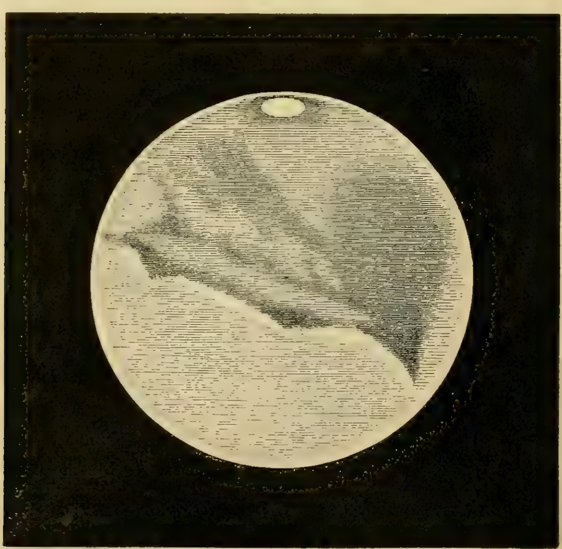


Fig. 2.—The appearance of Mars at longitude 90° with long oblique ridges south of the great boundary and nearly or quite running into the northern band: here less broad than in Fig. 3. Seen November 11th, 1832.

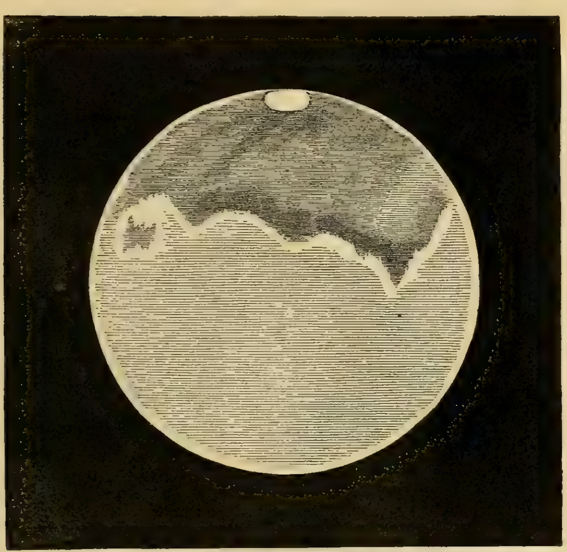


FIG. 3.—The hemisphere of Mars opposite to Fig. 1. Seen October 15th and 16th with a specially dark band.

FIG. 4.—The hemisphere of Mars opposite to Fig. 2. September 23rd, 1862.

effect of the vapour in arresting the outflow of heat may be greater. It is possible, however, that his atmosphere may be peculiar in quality, and may contain elements more capable of resisting the waste of heat than exist on ours. And these may not be beyond the ken of spectral analysis. So that without any unlikely suppositions we are provided with a fair explanation of the comparatively mild climate of Mars, and may expect from further research sure measures of the extent of his atmosphere, and certain knowledge of its constitution and action on radiant heat. If we could be quite confident of the exactness of some observations of Cassini and Rœmer, on the dimness and almost extinction of stars before and after occultation by Mars, we should have no doubt of his being surrounded by an extensive and partly cloudy atmosphere; but Sir J. South found no such obscuration, and concluded that either some physical change has occurred in the atmospere of that planet, or that the observations of Cassini were inaccurate. Perhaps the safe conclusion may be that the atmosphere exists, but is not always loaded with clouds, and this is in harmony with all that appears on other grounds to be likely.*

The greater our knowledge of the true constitution of Mars, the better chance have we of ascertaining the physical peculiarities of the other planets. We must not expect discoveries on them to proceed at so great a rate as on Mars. Mercury is too near the sun to be well seen. Uranus and Neptune too far from the earth. Of these planets, even the rotation period is not ascertained. Schröter, indeed, not only speaks of spots on Mercury, but gives measures of mountains rising above his surface, one more than one mile, and another nearly eleven miles, and assigns a rotation period of 24h. 5m. 28s. But in this, and in other statements, he is quite unsupported.

No great amount of definite knowledge is acquired regarding the surface of Venus or Saturn, though for these the rotation period has been assigned by means of some shadowy parts, whose recurrence has been observed, but not by modern instruments.

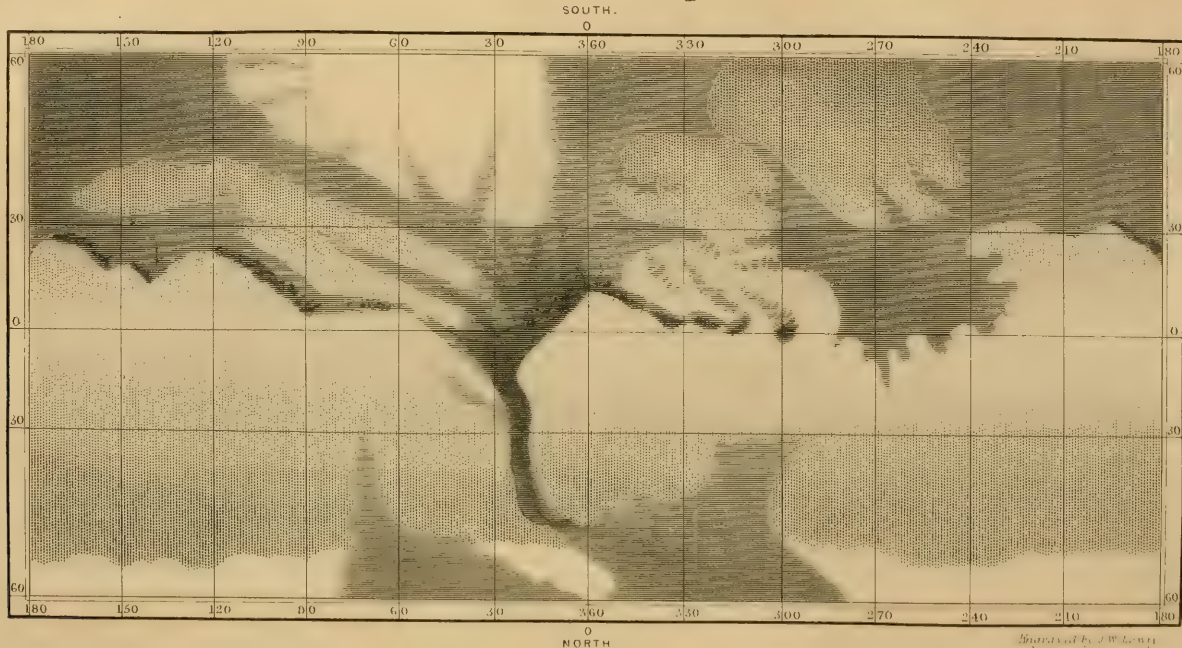
To Huygens, looking through a telescope 45 or 60 feet long, Venus appeared "all over equally lucid, without so much as one spot in her;" and after satisfying himself that no distinction of land and water could be traced in her, he asks, "Is not all that light we see reflected from an atmosphere surrounding Venus, which, being thicker and more solid than that in Mars or Jupiter, hinders our seeing anything of the globe itself, and is at the same time capable of sending back the rays that it receives from the sun."†

Yet in 1666, Cassini saw a spot on the edge like a bright prominence on the moon. In 1700, De la Hire discovered mountains in Venus larger than those of the moon; and Schröter not only saw mountains, but measured them.‡ Four of these were found to be elevated from 10 to 22 miles. Modern observers have not confirmed these statements; yet, during the present year, we have seen such

* 'Proceedings of the Royal Society,' 1831, 1832.
† 'Cosmotheoros,' first published 1684.
‡ 'Phil. Trans.' 1792.

Chart of the Planet Mars.

By Professor Phillips.



This Chart is founded on the observations made in 1862, separately, by Mr. J. N. Lockyer, and Prof. Phillips; repeated in 1864 by Prof. Phillips. Drawings made in 1862 by Mr. Main, and in 1864 by Mr. Dawes, have also been consulted. For the Northern circumpolar regions, and extent of southern snows, the engravings of Mr. De la Rue & Padre Secchi have been employed. The earlier designs of Herschel & Mädler have also been referred to.

differences in the distribution of partial light and shade on Venus, before sunset, as to give some reason for hope that it was not all cloud-land which was surveyed with the long telescopes of Cassini.

The rotation period of Venus was given by Cassini at 23h. 16m., and by Schröter at 23h. 15m.

Of the surface of Saturn, we have, chiefly, belts like those of Jupiter, but not so clearly defined; some spots from which the rotation has been computed at 10h. 16m., and some variable appearances about the poles which indicate atmospheric changes; for we dare not speak of polar snows in so distant a planet.

The observations on Jupiter, in some degree intermediate in character and in distinctness between those of Mars and those of Saturn, help to confirm the now general belief in the common origin and agreeing nature of all the planets. For here spots of a definite shape and place are traceable in the dark spaces between the bright belts; the belts are seen to change in extent and outline; they vary even in number, and are constant only in the direction parallel to rotation, and in the colour, which is that of cloud reddened by morning or afternoon sunshine, and this not equally in every part. The rotation is accomplished in 9h. 56m. This prodigious velocity, about 30,000 miles an hour at the surface, would have occasioned heavy cyclonic storms, and violent winds from the north-east and south-west, but for the nearly perpendicular position of the axis of the planet to the plane of the orbit—a circumstance also observed in Saturn, and productive of the same regular atmospheric currents.

ON THE PREDISPOSING CAUSES OF PESTILENCE.

There are many persons to whom the existence of disease is the most mysterious and inscrutable problem in Nature; who regard it as a phenomenon the most difficult to reconcile with the wise government of an all-merciful Deity. Such persons, along with others who do not trouble themselves to think at all, regard the advent of a pestilence with superstitious fear, as did their ancestors, considering it to be a scourge sent to punish man for his spiritual backslidings; his sinfulness often consisting, in their eyes, of a disbelief in, or neglect of, their particular views of salvation. Those, on the other hand, who are often derisively called optimists, look upon physical maladies as civilizing influences, having their origin in the neglect, not of spiritual but of moral and physical laws; and although they, too, fear the approach of a plague, it fails to awaken in them a superstitious and inexplicable dread, but calls forth renewed activity in the work of sanitary reform. A more pressing duty prevents us from entering further upon the philosophical consideration of the subject, but it will be found that what has been said of the present applies also to the past, and that the nature and predisposing causes of disease have always been similar to those which prevail in our time.

Whilst we are writing, the tidings reach our shores that a fearful epidemic is committing ravages in Russia, and anxious voices are raised in our deliberative assemblies inquiring into the nature of the plague, and whether it is likely to reach our sea-girt isle.

The nature of the disease is not clearly defined, but those who are the best acquainted with modern forms of epidemic maladies, pronounce it to be typhus and relapsing fever. In olden times, and even at present, in Eastern countries, this "formidable complication of typhus fever" was accompanied by "carbuncles" and "pestilential buboes," and the Russian epidemic, which is also characterized by these symptoms, is believed by the authority we are quoting * to be the modern form of the ancient plague. Not only, however, have these concomitant symptoms been found to present themselves in the Russian typhus, but inquiries have led to the ascertainment of the fact, that they are also sometimes present in the English form of the disease, which has been very prevalent of late years, and that not less than 150 cases of typhus in the London Fever Hospital have, during the last three years, been accompanied by these inflammatory swellings. The same excellent authority tells us that the Continental epidemic is almost entirely confined to the poorer classes; that it arises partly from a want of sufficient nourishment, and that its virulence and alarming spread are due to the fact that thousands of labourers are flocking into the large cities, overcrowding the pauper population to an inordinate degree; and thus "as this crowding increases, the fever which results from crowding (typhus) is gradually superadded to that which is more immediately the result of destitution (relapsing fever)." The same disease (typhus), we are further told, is also confined to the poorer classes here, and to clergymen and medical men who come in contact with them, and we need therefore not apprehend "the importation of the Russian epidemic." We confess our inability to appreciate the full force of this reasoning, which appears to be that as the worst form of the disease already exists in England, we need not apprehend its extension through the importation of the milder phase, but we must give the writer of the article from which we have quoted the benefit of the most important lesson that it inculcates, namely, that "we should not allow the Russian epidemic to create a panic, by encouraging the popular fear as to the invasion of these shores by a new disease," but "should endeavour to expel an unwelcome guest which for years has been spreading, far and wide, misery and death, but which with proper precautions ought no longer to exist amongst us."

But, we shall be asked, "What precautions are here referred to? What are the causes of the existence in England of a plague, the full danger of which is not made manifest until we hear of its raging abroad, and threatening to become more virulent through an imported accession of strength? Are, then, the conditions in which the poorer classes live in our own country *chronically* the same as those which have temporarily ignited this pestilential conflagration in large

* 'The Lancet.'

Russian cities; and is it indeed true that the best of men, those who labour to preserve our bodily and mental health, our medical and clerical brethren, walk daily in the haunts of disease and death, and that they are the only victims in the 'middle classes,' of the pestilence which is constantly decimating the lowest orders?"

These are the inquiries which we are bound to answer, and the following observations must serve as the replies.

If our readers were abruptly told that there are to be found *anywhere* in the present day thousands of human beings who live herded together so as to render the exercise of social and moral influences impossible, and in such a manner as to induce every form of vice, misery, and disease; that the air requisite for normal and healthy respiration in one individual is often distributed to a whole family by whom it is again and again inhaled along with their united exhalations; and that there are poor creatures who have become so completely habituated to this noxious state of existence as to dread the exposure to healthier surrounding influences whereby their old habits and associations would be broken or interfered with; they would regard the statements as exaggerated, or would imagine that they referred to the inhabitants of some African village, or to the snow-huts of the Esquimaux. But when we add that it is not in savage life, where Nature continues to some extent to maintain the sway whereby she keeps the lower animals healthy and unpolluted, that these abominations exist; but that it is in the very centres of civilization of the two foremost nations in the world, in the large cities of Great Britain and France, then we shall expect to be called upon for evidence in proof of our assertions. This we are unfortunately but too well able to afford, but before calling our witnesses we would add that not alone is the wretched mode of existence a misery to the poor creatures who are subjected to its influences, and fatal to those who are compelled by their avocations to visit and associate with them, but it spreads havoc and desolation around amongst the wealthy and intelligent, singling out its victims indiscriminately; here a son or daughter, there a father or a mother, and consigning them to an early grave; and thus illustrating the principle that no section of society can commit a breach of moral or physical law, without the whole being more or less involved in the punishment.

It is about twenty or twenty-five years since the governing bodies of the State and the municipalities of our large towns had their attention drawn to the mine upon which the people reposed in fancied security, a mine which was now and then sprung to the astonishment and horror of the ignorant, who could not understand that the combustibles were constantly accumulating below and only needed the spark to produce an explosion, but who looked upon the recurrent epidemic, pestilence, or plague, as an unwelcome visitor from foreign parts. The startling announcements of the inherent danger were made by a few individuals, whose official position had rendered them familiar with its existence, and the late Dr. W. H. Duncan, medical officer of the Liverpool Health Committee, was one of the most prominent of these benefactors of the people. He ascertained that 20,168 of the inhabitants of Liverpool dwelt in 6,294 cellars, many of them damp, close, and

totally unfit to be used as human habitations.* Also, that a very large proportion of the population lived (and for that matter *still* live) in courts, of which many were closed at one end so as to preclude ventilation, and some were almost, if not entirely, unprovided with conveniences for the deposition and removal of effete substances. On investigating closely the relation between these horrible dens and the ratio of disease in the town of Liverpool (which has still, we believe, the unenviable reputation of being, notwithstanding its natural advantages, the most unhealthy town in the three kingdoms), Dr. Duncan found that "the proportion of damp and wet cellars is greatest and least in the same districts where fever reaches its maximum and minimum;"† that the prevalence of fever in the different districts of Liverpool bears a general relation to the character of the courts, the state of the sewerage, and the density of population in each district,‡ and that these unhealthy conditions of existence in courts and cellars were well known, and had been reported upon *as far back as the year* 1802,§ but that they had been allowed to remain through nearly half a century, because "*inferior considerations triumphed over the public good.*"

Thus we find at the outset that, within the memory of many who are still alive, there existed in the leading seaport of Great Britain a state of things worthy of some native African village, or subterranean Arctic hovel, but extremely disgraceful to any civilized community; and we are forced to add, that when Dr. Duncan's report of 1843 is compared with that of the present excellent medical officer for the same town, published in 1865, we find that, although every effort is being made to mitigate the old evils, many of them still exist to an extent that would be incredible were they not presented to us accompanied with names, places, and every detail to assure us of their presence.

Leaving their consideration for awhile, we will direct our attention for a moment to another great commercial centre, the trading capital of Scotland, and in Glasgow we find that twenty years after the date of Dr. Duncan's report, namely in 1863, the poorest inhabitants were still in the same dreadful condition, and dragged out their wretched lives under similar circumstances to those recorded of the poor of Liverpool in 1843.

Dr. Gairdner, the medical officer of health for the City of Glasgow, says:‖—

"From inquiries made of one of the best informed district inspectors of the poor, I am quite satisfied that many fever cases, even in the worst possible sanitary circumstances, in the most over-crowded houses, in the midst of neglect, filth, and wretchedness, are not, and some of these cannot be, removed to the infirmary. I am equally well satisfied that so long as this is so, and so long as healthy persons are

* See his 'Essay on the Physical Causes of the High Rate of Mortality in Liverpool.' Liverpool: Walmsley, 1843.

† P. 49, loc. cit.

‡ P. 63, loc. cit.

§ By Dr. Currie. See conclusion of Dr. Duncan's Essay.

‖ See his 'Reports for April and July, 1863.' Glasgow: Robert Anderson.

unwittingly or unavoidably exposed to the contagion of fever in over-crowded and ill-ventilated apartments, sanitary visitation can only be an imperfect check upon the spread of this disease. The strong convictions I entertain on this subject, and the very decided support afforded to those convictions by the facts of the present epidemic, have induced me to recommend a more stringent application than heretofore of the new powers conferred by the Glasgow Police Act, in two of the most notorious fever localities; and I shall be guided by the effect of these recommendations in making further efforts in the same direction. It is of importance that in the application of these stringent clauses there should be nothing ill-considered, nothing arbitrary or indefensible. I am, therefore, well content that these two cases should be fully and clearly before the public as a basis for future action; and I hope that, by securing in advance the influence of free discussion and the support of public opinion to the measures proposed, they will be rendered both more safe and more efficient for the purpose in view—the gradual reformation, and in some cases reconstruction, of the houses of the poorer classes, in accordance with those conditions which can alone deprive epidemic disease of its most dangerous peculiarities."

And what are the "two cases" to which reference is here made?

We will give them, as far as these pages can do so, the publicity which Dr. Gairdner desires that they should enjoy, stating, however, at once, that through the unwearied efforts of that gentleman, these two plague spots, if they are not completely eradicated from the city that witnesses his labours, are at least no longer injurious to its inhabitants.

One is "Binnie's Court, 285, Argyle Street," in which we are told that thirty cases of fever had been visited between November, 1862, and April, 1863. This, we imagine, will wear, in the eyes of our readers, very much of the aspect of a chronic pestilence! And no wonder that it should exist there, for the building, or whatever it may be called, "is six stories in height, including the sunk floor, and in each story there are twelve apartments, principally let in single rooms to the working classes." These rooms were in such an overcrowded state that it was "dangerous to public health, and permanently injurious to the health and morals of the inmates." Some of the single rooms used as dwelling-houses contained only 600 cubic feet of space, and were occupied by four or five persons, "whilst the Act requires an *absolute minimum* of 300 cubic feet for each person over eight years of age, and 150 cubic feet for each person under that age."

But the second case, "No. 83, Drygate Street," was still more dangerous. It is known as "The Rookery," and "may be described generally as an almost perfect example of a deliberate plan for bringing together the largest number of persons in the smallest amount of space." The state of things to be found here beggars all description; an apartment of 497 cubic feet contains six adult inmates, "each of whom can scarcely have more than *one-fourth* of the minimum space allowed by the Police Act." . . . and "*the average size of the single rooms, intended for the habitation of a whole family, is but little greater*

than that formally condemned by the Royal Commission as insufficient for a single soldier in barracks! The amount of over-crowding in most instances may be easily imagined by any one who will take the trouble of measuring a space eight feet in each direction, and assigning it in fancy as a habitation for six adults. It is hardly necessary for me to say that I find in the facts above mentioned ample explanation of the prevalence of typhus fever in the Rookery." This is the first part of Dr. Gairdner's evidence, and no one will, we think, be disposed to dissent from his conclusions. There will be no need for tender-hearted readers hereafter to shudder over the accounts of the tragedy in the Black-hole at Calcutta; the report of Dr. Gairdner, and others, to which reference has still to be made, will furnish records quite as horrible, and even more repulsive in details.

But it is not necessary to confine our inquiries to our own country, for accumulated evidence of the truths advanced above is also to be found in the reports of the Sanitary Commission of Paris. This body of gentlemen, known as the "Commission des Logements Insalubres," was constituted in 1850, and forms a permanent commission, with full power to reform the character of the dwellings of the working classes in Paris. A passing notice of the constitution of this board may be useful to the English people, for it is not made up of amateur legislators only, whose interests (as we have already seen) are not always in unison with the public good, and upon whom an inconvenient pressure may often be brought to bear by selfish and awkward constituents, but it consists—1st, of public officers appointed by the State, such as the Inspector-General of "Ponts et Chaussées," the Water and Sewer Engineer, the Superintendent (chef de division) of Public Works, and four other gentlemen holding public appointments; 2nd, of members appointed by the Municipal Council, comprising the leading medical men attached to the various hospitals, of chemists, engineers, architects, one of the judges of the Civil Tribunal of the Seine, and private individuals; and 3rd, of supplementary members, also appointed by the municipality, as circumstances may direct.

The results of having a committee thus constituted are unanimity of action and the issue of just and feasible recommendations. Those who have watched the efforts which have been made in England to enforce sanitary reforms by bringing the offenders before the lay magistrates must have noticed that differences constantly arise between them and the guardians of the public health, and that private feelings and prejudices are often an increment in the judicial decrees; but in the French Commission no such difficulty is to be apprehended, inasmuch as different members of the commission are competent to decide in all matters of law and detail with the same precision as if they constituted a final court of appeal.

A further advantage in the operation of the French Commission over some of our local boards, is the *moral* influence which its decisions carry with them. In England an offender may often feel that his security lies in the chance of the magistrate taking a lenient view of his case, and differing from the sanitary officer, and so he may be induced to turn a deaf ear to the voice of justice and morality until

the law compels obedience; whilst in Paris it is so well known that the criminal tribunals are sure to endorse and give effect to the well-considered recommendations and decisions of the "Commission des Logements Insalubres," that offenders are only too glad to repair the breach of the law (as we shall presently find they do in the large majority of cases) by what our neighbours call a settlement "à l'amiable," an expression so *expressive* that there is no need for its translation.

In the Report issued by the Commission for 1852 to 1856 inclusive,* we find the following pointed out as the prevalent causes of disease—unhealthy interiors (of dwellings), resulting from want of cleanliness, insufficient light, imperfect ventilation, want of space, occupation of cellars, imperfect water supply, inefficient drainage, humidity, and overcrowding! precisely the same catalogue of evils that have so long desolated the homes of the poorer classes of Britain; and in a later Report† of its labours, the Commission refers particularly to the character of the cellars which are deemed unfit for human habitations. Some of these are described as mere caves, into which a little light and air is admitted through external openings, and it is to these especially that the attention of the Commission has been directed. They have, of course, prohibited their use as day and night dwellings.

In perusing these reports we may be permitted to remark en passant, that it is impossible not to perceive the fitness of the present form of government in France for certain of the people's wants, and the need that exists for caution in pronouncing upon the suitability of this or that mode of legislation. Imperial rule in Britain would be out of place, and centralization is the abhorrence of Englishmen, but if our readers were to glance over these reports, they would find that the acts of the French legislature in ameliorating the condition of the working classes are probably the very best that could be devised, looking at their position in the moral and intellectual scale, and that there exists a thorough understanding between the people and its rulers.

Whilst with us private individuals, companies, and municipal councils are occupied with the "Utilization of Sewage" question, in France the initiative is taken by the State; and in furtherance of another important matter, usually promoted in England by private individuals, namely, the erection of model lodging-houses, we find the coffers of the Imperial Treasury freely opened; for we are told in the report referred to, that his Excellency the Minister of the Interior having acquainted himself with the nature of the project for providing lodging-houses for the working classes at Lille, had granted 100,000 francs to facilitate the construction of these dwellings. It is a pity that we English cannot find it in our hearts to cast away a little of our self-complacency, and that we do not study the ways of our neighbours with a view rather to profit by their good example than to criticize their imperfections.

* 'Commission des Logements Insalubres—Rapport Général sur les Travaux de la Commission pendant les années 1852, 1853, 1854, 1855, et 1856.' Paris: Charles de Mourgues Frères, successeurs de Vinchon, Imprimeurs de la Préfecture de la Seine. Rue Jean-Jacques Rousseau, 8. 1857.

† 'Rapport, 1857, 1858, 1859.' Same publishers.

The report of the commission gives a list of the cases in which it has interfered, and we find that in 1857 there were 492, of which 369 were adjusted amicably, and the remaining ones referred to courts of justice; in 1858, 512 cases, whereof 355 pleasantly terminated; and in 1859, 641 cases, of which 373 were amicably settled; thus it appears that the Commission finds its reformatory labours extending and becoming more and more difficult in execution.

Let us now turn again to our home records of a more recent date, and we shall find that although our Boards and Committees of Health have been unremitting in their exertions to suppress the unhealthy and demoralizing conditions of the poorer classes, yet their extended inquiries have revealed a state of things almost too repulsive to be transferred from the cold and formal reports of medical officers intended only for the guidance of local boards, to the pages of a Journal destined for the general reader.

But in the fulfilment of our task, it is absolutely necessary that we should extract a few of the more flagrant cases of neglect and ignorance, often bordering upon crime, which, as we have already stated, are sapping the very foundations of our social system and converting our crowded cities into hotbeds for the reception of epidemic diseases.

In his report for August, 1864, Dr. Gairdner, the medical officer of Glasgow, tells us that he sometimes feels completely helpless when he "sees diseases, as measles, hooping-cough, and scarlet fever, running riot in the houses of the poor;" he feels that, in most instances, nothing can be done beyond a general instruction to open the windows, and attend, if possible, to cleanliness. He further states that he has found provisions publicly sold from infected apartments, instancing a case where "a woman with the eruption of smallpox actually on her hands, was found selling sweetmeats to the children of a school in her neighbourhood!" If such a story had been told in some romance of 'The Plague of London,' or if it had found its way into 'The Mysteries of Paris,' it would not have been out of place; but it is enough to chill the blood in one's veins to read it as an actual fact in the report of a medical officer of health in 1864.

And what is the remedy for such a state of moral darkness? Dr. Gairdner tells us that the law is incapable of dissipating it, and that "the spread of epidemic disease among children can hardly be met otherwise than by the gradual diffusion of enlightenment, and by the improved habits which, it is to be hoped, may arise from the remodeling of the dwellings of the poor over a long course of years."

Even the attempt to prevent the overcrowding of those dens which are at present used as dwellings for the poor is not always successful, and although it is a matter for congratulation that the two infamous localities referred to in a former part of this paper, "the Drygate Rookery" and "Binnie's Court," are to a great extent freed from epidemic fever, in consequence of sanitary improvements, yet Dr. Gairdner tells us, that "in another street in the same neighbourhood (in which a great deal of fever has been reported), fifty-two houses have been ticketed, all of these, except four, being houses of single apartments; the proper complement of these fifty-two houses, accord-

ing to the terms of the Police Act,* is 154 adults, and yet on the June visit of the police, there were found 186 adults and 64 children, almost all single families without lodgers." Dr. Gairdner does not consider the landlords responsible for this overcrowding, for the houses are usually sub-let; but he urges the owners only to let the houses subject to the regulations of the Police Act as to overcrowding. Neither does he recommend summary evictions, which cause great inconvenience and distress, and simply transfer the evil complained of (overcrowding) to some other quarter, perhaps to some previously untainted locality; but like the Paris Commission, he recommends that all cases should, if possible, be amicably adjusted and sanitary reforms introduced into the habitations where the exciting causes of disease have been seated; in fact, that a good understanding should be cultivated between the authorities and those who are unfortunate and ignorant, rather than wilful offenders against the laws of nature and society.

The Paris Commission, whose reports testify through their increasing bulk to its great activity, has, during the last four years, performed marvels in the way of sanitary reform.† They have had a difficulty to contend with, happily no longer experienced here; namely, an imperfect water supply for the interiors of dwellings. "In Paris," the report says, "fountains are multiplied, and many of them serve at the same time for the embellishment of the city and to satisfy its domestic wants, whilst in London, there are no public fountains, no monuments, nothing to adorn the public thoroughfares, but all is reserved for the interiors of the houses: thus the differences in the manners of the two peoples are revealed;" and then it goes on to speak in terms of high commendation of the water-taps, and water-closets, and shower-baths found in England in the houses of working men paying 125 to 150 francs rent; luxuries supplied to the fortunate tenants at an annual charge of about eight francs, or 5 per cent. on the rent: 'A Rugby, petite ville de 8,000 habitants, sur les 1,100 maisons 700 à 750 ont exécuté leurs prises d'eau et ont au moins deux robinets, l'un dans la cuisine, l'autre au water-closet." We fear that our French readers will not think so highly of our sanitary arrangements after the revelations which we are compelled to make, but certainly the picture that has been drawn of us by the Sanitary Commission of Paris, may well serve to obliterate from the minds of indignant Englishmen those sketches of English society with which some French penny-a-liner lately entertained his countrymen. *Thinking* Frenchmen seek out the useful traits in the social life of England, and turn them to good account, and it would be well if thinking Englishmen would profit by the good taste of their neighbours, and employ their resources in the erection of public structures that shall at once adorn our cities and supply our social requirements.

The Commission, as we have said, finds the need of a better water supply to the tenants of houses, for they observe, that there can be no health without cleanliness, and no cleanliness without abundant and

* See Dr. Gairdner's 'Report, August 1, 1864, p. 12, note. 'Glasgow Police Act.'

† 'Rapport Général, &c., 1860–61.' C. de Mourgues Frères. Paris, 1863.

wholesome water; and when therefore this sanitary element is absent, the Commission does not hesitate to enforce its introduction. Thus, they describe a house in the "Rue de la Montagne Sainte Géneviève, containing 200 inhabitants in 80 different apartments, besides a school, and yet this whole structure is without water supply, and the inmates have to seek that commodity out of doors." Consequently the commission "recommended that the proprietor be instructed to place at the disposal of the tenants wholesome water sufficient to guarantee the cleanliness of the various apartments and offices." Of course, the "recommendation" is law, and it is pleasing to observe, that whilst the Commission are inflexible in their determination to reform the habitations of the poor, they have recourse to extreme measures only as a last alternative. "Thus," they say, "when we decide upon rigorous measures, such as the interdiction of a dwelling, it is only after a searching inquiry, repeated visits, and earnest deliberation," and in all cases they seek first to act as mediators between landlords and tenants, before exercising their legislative functions.

Wishing our neighbours every success in their sanitary reform, and perfectly satisfied that the spirit in which they are conducting their operations will *ensure* success, we once more, and for the last time, turn to the sad pictures of wretchedness and to the threatening dangers which present themselves in our own large towns. In his last Report for 1864,* Dr. Trench, the medical officer for Liverpool, referring to the causes of disease, attributes it to—1st, Contagion; 2nd, Indigence; 3rd, *Overcrowding;* 4th, Emigration; 5th, *Sub-letting rooms;* 6th, *Filth;* † 7th, Drunkenness. Of overcrowding he gives some examples which are really almost incredible; and whilst he tells us that it would be impossible to find 40 men sleeping in a cellar, as described by Dr. Duncan, still we fear our readers will think with us, when they have heard how matters stand at present, that there is much room for sanitary reform.

Remembering that the minimum cubic space required for each adult (by the Glasgow Police Act, and Liverpool Board of Health), is 300 feet, and that the Government Commissioners recommended 700 and 800 feet per man for soldiers in barracks, we will now conduct our readers to two or three of the *homes* visited by Dr. Trench or the Inspectors.

The first is the lodging-house of Mary Bartley, No. 9, Trueman Street, Liverpool. It contains eight rooms, one of which was found empty, and another was used as a kitchen by the tenant, the remaining six rooms constituted dwelling-houses for families, there being in all twenty inmates in the six rooms, and in one of the rooms, 998 cubic feet in its dimensions, *two young married couples were found to exist, with only one large straw mattress for a bed!* Two couples of young married persons thus herded together by day and by night, in a room measuring less than 10 feet in every direction, breathing the

* 'Report of the Health of Liverpool during the year 1864.' Liverpool: Greenwood.

† We italicize the words.

same air over and over again! What a favourable condition of existence for the cultivation of the higher, or even the lower moral faculties! Again we say, it is enough to make one shudder to read of such scenes, chronically existing in the very midst of our boasted civilization.

But there are still worse cases. In No. 27, Chisenhale Street, Michael Lonergan occupied a house, one room of which, 802 cubic feet in measurement, served as the abode of three persons. Mary Roach, 19, Brick Street, rented three rooms, together about 2,700 to 3,000 feet, sheltering seventeen persons! Sarah Goughran, No. 21, in the same street, had also three rooms, containing the same number of persons, and in these rooms, *there was literally no furniture whatever; men, women, and children lying together promiscuously on straw, or on the bare boards!* *

We recommend these cases to the consideration of all pious persons, whose philanthropy finds its issues in public speeches in favour of African missions, or in the propagation of the gospel among the Jews, or in foreign parts!

And now as regards the absence of cleanliness, the nature of the subject compels us to be still more brief. "Any history," says Dr. Trench, under the unsavoury heading of 'Filth,' † "any history of the causes favouring the extension or diffusion of typhus, would be incomplete which did not include the filth, foul smells, and vitiated air *within* rooms; or the noxious exhalations from open middens and heaps of decomposing vegetable and animal refuse in the immediate neighbourhood of houses. It would indeed be difficult to overrate the force of such auxiliary and predisponent influences, which are only

* Since this article was written, official reports have described even more unhealthy and immoral scenes of overcrowding in country districts than any here noticed as existing in our large towns; and if any further evidence were needed to establish the causes of typhus and other epidemics, it is to be found in the Report of the Government Inspector, from which we make the following extract:—

"To sum up:—Destitution, dirt, and intemperance, with overcrowding and bad ventilation of streets and houses, are the conditions that keep up the disease steadily from year to year. The reasons why typhus has become epidemic are not so clear. The only positive conditions that have been ascertained appear to be these—slight but steady increase in overcrowding, some increase of immigration and of distress at the end of 1861, some increase of vagrancy, and with these some influence in each autumnal season. But these causes are not sufficient to account for the epidemic. Typhus, like other contagious diseases, fluctuates in its amount at different periods; at one time occurring in scattered cases only, at another time extending widely over the community. What determines it to assume the epidemic form can sometimes be made out—an exceptional intensity of the conditions that foster it in ordinary times. But sometimes its prevalence as an epidemic cannot be thus explained. Like other diseases of its class, *with predisposing conditions apparently constant*, it has times of subsidence and times of prevalence that medical science cannot yet explain.

"The negative conclusion at which this report arrives concerning the causes of the present epidemic may appear at first sight unsatisfactory. But it is not without its value if it shows that efforts for preventing epidemics of typhus must be applied not chiefly at the times of the epidemic itself, *but to the improvement of certain habitual conditions that can be recognized as fostering the disease in ordinary times.* Some of these conditions are within the range of public sanitary measures, others are connected with social circumstances over which no direct public control can be exercised." (The italics are ours.)

† 'Report of 1864,' p. 35.

second, if at all inferior, in magnitude and importance to those of either destitution or overcrowding." We will spare our readers, many of whom are, we feel sure, as much pained to read, as we have been to write these shocking details, the unpleasant task of wading through the quagmire that follows, but to demonstrate once for all that filthy, overcrowded, and otherwise unhealthy homes *are* the true causes of the spread of pestilence, we select from Dr. Trench's 'Analysis of Deaths from Typhus during one week,' the following cases :—

"*First death.*—An office clerk. He had a wife and four children, and earned 20*s.* a week. 'The wife supposed to take drink.' *The house dirty and poorly furnished.*"

"*Second death.*—A carter. He had a wife and one child, and earned on an average 20*s.* a week. His wife 'addicted to drink heavily.' Of the house it is added, '*Poverty and filth in the extreme.*'"

"*Third death.*—A labourer's child. The labourer's family consisted of wife and five children, and he earns 3*s.* a day, occasionally. 'A steady man, with a drunken wife.' '*The house having every appearance of misery and filth of the lowest order.*'"

"*Fourth death.*—A labourer's child. 'The parents have left the house. They were comfortably off as regards money.' 'Continual drunkenness *and filthy in habits.*'"

* * * *

"*Tenth death.*—A market porter's child. The family consisted of man, wife, and four children. The average earnings 12*s.* to 15*s.* per week. No information respecting morals, but thinks, by appearance, a deal of dissipation. *Dirt and destitution in the house.*"

In many of the other cases we find the words "intemperance, dirt," &c. ; and it will be observed that in every case quoted, it is not the drunken mother, but the unfortunate father or innocent child, whose unhealthy home makes him the victim of disease and death. What becomes of the wretched mother, when she is left with her tribe of sickly children, and is deprived of the means of indulging in the vice that has converted her into the slayer of her husband or child, we leave to the imagination of our readers!

To some of the last-named it may appear that we have needlessly dragged to light scenes of wretchedness and demoralization which might have been passed over in silence, and that we should rather have suggested the remedy than have entered into the details of the existing disease. But, alas! if we turn to the account of the means that have been adopted for remedying the evil we find the same horrible phases, and, as it may naturally be supposed, we perceive that the present state of things can only be completely reformed by tearing out the tree at its very root—so that whether we take up the records of existing pestilence, or those of the reformatory measures that have been adopted for its eradication, the same repulsive features constantly present themselves. There exists in the very heart of our civilization, a loathsome sore which no dainty fingers can heal, and no sentimental suggestions can ameliorate ; but which *men* and *women* must help to root out from the social system. The cures for overcrowding are to be found, in model lodging-houses,

in small well-built and well-fitted cottages, such as are springing up in all the outskirts of our great towns; in the encouragement of "Home Missions," and Educational Establishments for the poorest children; and generally in the *firm* but *conciliating* interference of local authorities in sanitary arrangements. All these matters require that false delicacy should be put aside, that much self-denial should be exercised both by giver and receiver, and that the great mass of the people should be awakened to the dangers in the midst of which they have so long reposed in security. Does it not seem a dreadful thing to say, that if a conflagration were to sweep over a very large area of Liverpool, London, Glasgow, or indeed over the low parts of any of our overcrowded cities, it could only be regarded as a blessing to the wretched creatures who would be temporarily rendered homeless? And yet who will deny it, after reading Lord Shaftesbury's statement,* that when "Wild Court, Drury Lane, London, was rendered habitable by the 'Labourers' Friend Society' (who pulled down the houses and rebuilt them as models), the vermin lay beneath swarming in living masses in layers, from two to three inches thick, and that the well-known insects ejected from the houses amounted at least to a ton's weight."

We might refer fully to the labours of the late Prince Consort, Lord Kinnaird, Earl Shaftesbury, Miss Burdett Coutts, Mr. Peabody, the managers of the "Labourers' Friend Society," the Rev. Cecil Wray (of Liverpool), Mr. Peacock, and others, who, from philanthropic motives, have promoted the erection of healthy dwellings; but these examples are, from their very rarity, so well known, that it is needless to dwell upon them. There is another feature in the model lodging-house movement which deserves special attention. When conducted with a view to profit, as it has been both by private individuals and Joint Stock Companies Limited, the adventure is remunerative, and this is the guarantee for its extension. We have looked over the reports of existing Models, and watched the growth of small cottages situated even at a distance from the centres of labour, and they leave no doubt concerning their success as pecuniary investments. There are many persons, not always of the wealthier classes, who would gladly give their thought and leisure to supplement the capital of those to whom 10*l*. or 50*l*. is no object, and would aid in the formation of Joint Stock Model Lodging-house Companies; and there is no reason why such establishments should not be at least as plentiful as hotels—if not as *gin shops!*

Here, then, is one of the great resources of modern wealth and civilization which can be advantageously applied to remove the prevalent causes of contagious disease; and not alone will philanthropists be easily found to undertake the formation of the new abodes for the unfortunates whose "homes" we have been describing, but the officers of health will be grateful to these who provide shelter for

* See 'The Report of the Lodging House Committee,' prepared by Dr. Trench. Liverpool: McCorquodale (1864).

the poor diseased creatures whom the police regulations will inevitably turn into the streets, or drive into pure and still untainted localities. We trust, then, that the effect of this article will be, not only to create a little sensation and sympathy for those who at present live in our cities herded together as cattle, or like slaves in a ship's hold, but that it may here and there move the hearts of good men and women to assist, with heart and hand, in the foundation of self-supporting model lodgings. Another good plan of reforming the unhealthy habits of the poor which has been discussed, but not, we think, practically or extensively followed out, is the distribution, in the lowest neighbourhoods (through the medium of town missionaries, *and of the more intelligent of the class intended to be benefited*), of very brief, pithy instructions for the sanitary regulation of homes: stating, for example, the best means of ventilating crowded rooms, and the consequences of the neglect of such precautions, inculcating the necessity for cleanliness, &c. Here is a work for our Mutual Improvement Societies and Literary Institutions, which will be far more useful to society at large, and to the members themselves, than debates upon historical subjects long since exhausted.

These are but two or three out of a great many ways in which the general public, or earnest individuals, can aid in the reform of the dwellings of the poorer classes; but there are still others. In Liverpool, a lady, whose name we forbear to mention, as it may not please her to have it published farther than her good deed has already made it known in her own town, communicated to the Health Committee of the Town Council her wish that they should pull down a house of which she was the proprietor, and which she had been advised was unfit to be used as a human habitation. We hardly expect that many others will be found willing to follow the example of this excellent lady, but there may be some who would prefer this course to leaving such plague spots as legacies to their posterity.

And again, the Railway Companies, who do not stand very high in popular estimation at the present moment, may win golden opinions by facilitating the transit of labouring men to and from their workshops or sheds, and thus helping them to remove their dwellings to healthier localities;* and Companies so disposed would not only be doing a good work, but would undoubtedly be acting in the interest of their constituencies.

As the title of this paper indicates, its original object was to point out the predisposing causes of what is vulgarly known as "plague" or "pestilence;" but the terrible scenes that have presented themselves during its composition have induced us to deviate somewhat from the original plan, to draw the attention of our readers to those remedial measures which are being employed to remove the impending dangers. None will be disposed to gainsay that we are not surrounded by conditions in the highest degree favourable for the reception or extension of any new epidemic, or any exaggerated form of an existing one, that may visit us; and we therefore conclude these

* As is already done in the Metropolis.

remarks with the expression of an earnest hope that amongst our scientific readers, who must, indeed, be fully alive to the grave nature of the evils to which attention has been directed, many will be found to give the subject their serious consideration, and who will bring energy and experience to bear in the work of their eradication.

AMERICAN CONTRIBUTIONS TO SPECTRUM-ANALYSIS.

By HENRY DRAPER, M.D.,
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ALTHOUGH the fact that a ray of white light consists of several differently coloured rays has been known since the time of Newton, it is only recently that any use has been made of it, in attempting to determine with precision the chemical composition of substances, from the characteristics they impart to flames. A long stage of preparation for perfecting such discoveries is necessary, and a multitude of preliminary observations have to be grouped and digested. Eventually, some striking application of the knowledge thus gained arises, and the subject becomes popular among scientific men, who had failed to see any interest in the previously isolated experiments. It was not, for instance, until Bunsen and Kirchoff ascertained the presence of cæsium and rubidium in certain mineral waters, by the aid of the spectroscope, that that instrument attracted the attention it deserved. Even the suggestion that by its aid the physical constitution of the sun and stars might be ascertained, had not sufficed to bring it into notice.

The application of Spectrum-Analysis to Chemistry turns on the fact, that several, if not all, the elements impress a special change on a flame in which they may be volatilizing. In many cases the change is obvious to the eye, while in others it is necessary to pass the light through a prism, in order to observe with precision what has taken place. We have not, as yet, any knowledge of the reason that some bodies in volatilizing give rise to undulations of a particular length, and others to an entirely different group, we merely know that such an element as sodium, for example, causes vibratory movements, whose length is a definite fraction of an inch, and which pulsate a given number of times in a second, and that *no other element can do the same.* Whether the hypothesis of Professor Hinrichs of the Iowa University, that the discovery of the laws governing the distribution of the spectral lines will lead to a knowledge of the relative dimensions of atoms will turn out to be true or not, remains to be seen. If it be true, Optics would do for the determination of the form and size of atoms, what Chemistry has done for the determination of their relative weights.

The earliest American experiments in relation to the Constitution of Flames, the Solar Spectrum, &c., were published by Professor John W. Draper, in the 'Philosophical Magazine,' 'Silliman's Journal,' and 'The Journal of the Franklin Institute,' commencing in

1834. As these results were attained at a period when the number of facts known was limited, and when the interest in the phenomena of light now excited did not exist, an abstract of them may be presented with advantage.

Professor Draper's Researches.—The general plan of these investigations, which occupied many years, was—1st, to determine the conditions of incandescence of solid bodies; 2nd, the nature of flames; and 3rd, their variations at different temperatures. I shall therefore speak of them in that order, premising some remarks on the forms of spectroscopes that were used.

I. *Spectroscopes.*—The spectroscope first employed was similar to that used by Fraunhofer, consisting of a distant slit, a prism either of flint-glass, or bisulphide of carbon, and a telescope when visual observations had to be made, but suitably modified for photographic investigations. As is generally understood, this form of apparatus will give very excellent results, but the space occupied by it renders it less manageable than the more recent forms. By its aid, modified, as has been said for photographic purposes, the extra-spectral fixed lines above H, *viz.* M, N, O, P, were discovered by Dr. Draper, as impressed on a daguerreotype plate, and an engraving of them published in the 'Philosophical Magazine,' for May, 1843. He estimated that there were were about 600 of these lines so impressed between H and P. In like manner three lines, α, β, γ, of less refrangibility than A, were also detected. These latter lines were attributed to absorption by the earth's atmosphere, the others to the atmosphere of the sun.

But Dr. Draper also made use of another form of spectroscope, which does not seem to be even yet thoroughly appreciated. He replaced the prism with a grating or finely-ruled reflecting surface, the advantage of this being that the absorption of dioptric media was avoided, and the fixed lines, as it may be said, occupied their proper positions in the order of their wave-lengths. The prism separates the lines unduly towards the violet end, and crowds them together towards the red. On the contrary, in the interference spectrum from a grating, the yellow is in the centre, and the light declines away towards the violet end above, and towards the red below.

With this form of spectroscope the fixed lines were photographed, as in the other instance, and maps of their position published. By its use also, Dr. Draper was enabled to settle the question, which could not be determined so decisively with the prism, namely, the distribution of heat. It was shown that the centre of the yellow space is the hottest, and not a region less refrangible than the red, as is the case in Herschel's prismatic experiments, and that from that point the heat intensity declines towards the violet above, and the red below.

In these delicate heat experiments, advantage was taken of investigations that had been published by the same author in the 'Philosophical Magazine,' June, 1840, under the title of 'Electro-motive Power of Heat;' and in which some exceedingly delicate forms of thermo-electric combinations had been described.

II. *Of the Incandescence of Solids.*—The first formal memoir of the

series now to be considered, was published by Dr. Draper in the 'Philosophical Magazine,' May, 1847, under the title of 'The Production of Light by Heat.' The chief points experimentally determined in it are the following: 1st, that all substances become red hot at the same thermometric degree, which is 977° Fahr.; 2nd, that the light of an incandescent solid examined by the spectroscope is continuous, or without lines or breaks; 3rd, that at the same temperature there is always emitted the same ray; 4th, that as the temperature rises, rays of increasing refrangibility are added, and when the substance is intensely white hot all the rays of the solar spectrum are present. By direct photometric measures, founded upon the principle known as that of the extinction of shadows, he proved that the brilliancy of the emitted light increases more rapidly than the temperature. He also gave the true explanation of that apparent increase downwards, in the less refrangible rays, which the spectroscope exhibits at high temperatures, as depending on the physiological peculiarities of the eye.

It may, in passing, be remarked that a strip of platinum ignited by a regulated voltaic current, was in these experiments recommended as a UNIT LAMP, or standard source of light and heat, in the mode that has since been followed by Professor Tyndall.

Of so much importance was this memoir considered by Melloni, that he read an abstract of it, and critique upon it, before the Royal Academy of Sciences at Naples.

It is greatly to be regretted that M. Kirchhoff, in the memoir he published in 'Poggendorf's Annalen,' and of which a translation was printed in the 'Philosophical Magazine,' July, 1860, did not profit by the example Melloni had set. On page thirteen of the last-quoted work the facts that a platinum wire, as its temperature is raised, emits rays of increasing refrangibility, that all bodies become red hot at the same temperature, and emit special rays at special temperatures, that the spectrum of an ignited platinum wire is continuous, are presented as the results of his own mathematical investigation. From the obscure foot-note upon that page, no reader would ever infer that all these points had been proved by experiments by Dr. Draper many years previously.

III. *Of Flames.*—In continuation of the preceding investigation, Dr. Draper published, in the 'Philosophical Magazine,' February, 1848, a Memoir on "The Production of Light by Chemical Action." In this, resorting, as has been subsequently continually done, to a solar spectrum as the standard, and to the fixed line D, tables were published of the spectra of alcohol, carbonic oxide, cyanogen burning in air, cyanogen burning in oxygen, oil in air, and also in oxygen, hydrogen in oxygen, nitrate of strontia, &c., as seen in the spectroscope. The convenience of reducing these flames to the yellow ray D, has since been universally recognized. In like manner five such tabular results of platinum ignited to different temperatures, referred to the solar spectrum as a standard, had been previously published. In the case of flames, the line D in these memoirs is described as Brewster's yellow ray, in commemoration of Sir David Brewster's

discovery of the monochromatic character of a sodium light. In both these spectroscopic and also photographic experiments, the principle of identifying effects by wave lengths was resorted to, a suggestion naturally occurring from the use of the interference spectrum.

IV. *On the Variations of the Light of Flames with the Temperature.*—One of the most important facts demonstrated in these memoirs, indeed, it almost rises to the position of a general law, is this—"*that the more violent chemical action the more refrangible the emitted light.*" In the combustion of an elementary solid, such as carbon, if air be more and more vigorously supplied, rays of continually-increasing refrangibility emerge, and if, instead of air, oxygen be used, the resulting spectrum rivals that of the sun in brightness and extent. On this principle, that increasing vigour of chemical action implies increasing frequency in vibration, Dr. Draper gives an explanation of the colours emitted by flames. Thus carbonic oxide burns with a blue light, because it needs but little oxygen to complete its combustion, but the light of burning cyanogen increases in refrangibility when its combustion is made in oxygen gas. Among the most striking of these results, as showing the complete control that the circumstances of a combustion have over the character of a flame, is the extraordinary spectroscopic appearance of the blue blowpipe cone, when contrasted with the flame from which it originates, a singular instance which has been much overlooked. In descriptions of the changes in the spectrum caused by variations in the rate of combustion, the appearances produced by substances volatilizing in a flame, must not be confounded with those produced by a body that is oxidizing. There is no reason at present to believe that the spectral lines in the former case can be made to alter their position by increase of temperature, although new ones may be rendered visible.

In these memoirs, and also in others 'On Phosphorescence,' and 'On the Chemical Action of Light,' subsequently published, there is a multitude of facts and observations, full of interest, but too numerous to quote in this abstract. Among such, perhaps, I might mention the Chlorine and Hydrogen Photometer, subsequently used so extensively by MM. Bunsen and Roscoe, and the attempt to show that the Fraunhoferian lines are arranged in a certain symmetrical order, herein to some extent anticipating the remarks of Professor Hinrichs, before referred to. It should also be added that many other experiments in Photo-Chemistry were published by Dr. Draper, in a quarto volume of 324 pages, illustrated by engravings, under the title of 'A Treatise on the Forces that produce the Organization of Plants.'

Mr. L. M. Rutherfurd's experiments.—'Silliman's Journal,' Nos. ciii., 1863; cv., 1863; cvi., 1863. In December, 1862, Mr. Rutherfurd determined to continue Fraunhofer's experiments on stellar spectra by means of a refracting telescope of 11¼ inches aperture, mounted equatorially, and driven by a clock. He used at first an ordinary spectroscope, with the slit inside the focus of the large achromatic, but finding the loss of light upon the jaws of the slit to be very great, eventually employed a cylindrical lens, as Fraunhofer had done. This also frees the spectrum from longitudinal lines. He observed that a

spectroscope thus mounted is useful for determining the achromaticity of the telescope. If the different rays have foci at different distances from the objective, the slit must be moved in order that each ray may pass as a point. The place of the photographic focus may be thus ascertained with precision.

Mr. Rutherfurd examined the spectra of the Sun, Moon, Jupiter, Mars, Capella, β Geminorum, α Orionis, Aldebaran, γ Leonis, Arcturus, β Pegasi, Sirius, Castor, α Lyræ, α Aquilæ, Procyon, Regulus, β Ursæ Majoris, ζ Ursæ Majoris, ϵ Ursæ Majoris, δ Ursæ Majoris, and printed a plate of them in 'Silliman's Journal,' vol. xxxv., May, 1863. α Virginis, β Orionis, ϵ Orionis, δ Orionis, ζ Orionis, α Ursæ Majoris, gave no lines. He found absorption bands in the spectrum of Jupiter between C and D, and suggests the explanation that these, together with the remarkable bands of α Orionis, Aldebaran, and β Pegasi, may be due to the action of the atmospheres of those bodies. He classifies stellar spectra into three groups. 1st. Those resembling the Sun, as Capella, β Geminorum, α Orionis, Aldebaran, γ Leonis, Arcturus, β Pegasi; all reddish or golden stars. 2nd. Those of which Sirius is the type, wholly unlike the sun, and white. 3rd. Those like α Virginis, white, but showing no lines; they are perhaps incandescent, without flame, or contain no mineral substances. A great difference in the composition of stars is rendered evident.

Another communication in the same volume commences by giving a number of measurements of the companion of Sirius, and demonstrates that it has changed 3° 37′ in angular position, and 0·55″ in distance in a year, which would give a period of about 100 years if the plane of motion is perpendicular to the line of sight. He mentions a change made in his stellar spectroscope, by which a sodium flame is kept constantly in the field. By the check thus established, he proves that each line of the spectrum of Arcturus has its counterpart in that of the sun. His large spectroscope is also alluded to. The telescopes are 20 inches of focal length, and $1\frac{6}{10}$ inches aperture. It has six prisms of brass, with plane glass sides. He finds that the bisulphide of carbon is very changeable in density, and that the brass frames disturb the plane glasses when there are great variations of temperature. On examining the line D, it is seen to be composed of nine lines, a result subsequently corroborated by the use of eleven prisms: the line B is resolved into fourteen. He also describes other peculiarities, particularly in the neighbourhood of A, and in the potash spectrum.

In a letter in No. CVI., Mr. Rutherfurd criticises the stellar spectroscopes of Donati, Airy, and Secchi, giving the preference to the last, because it effects the separation of the lines by the dispersion of its prisms, rather than by the power of the observing telescope, and because it possesses the means of constant reference to a standard flame. He remarks that in the line D, four of the nine component lines are solar, the rest telluric, because these latter, though difficult with eleven prisms at noonday, are seen with ease near sunset with two. This conclusion is similar to that of Dr. Draper, concerning the invisible lines α, β, γ, discovered by him below the red end of the spectrum.

Mr. Rutherfurd has also taken photographs of the solar spectrum on the same scale as the map of Kirchhoff, but no detailed account has as yet been published. His other labours in celestial photography, and more particularly his lunar pictures, are so well known that no description of them is necessary.

Professor Rood's Experiments.—In 'Silliman's Journal,' No. C., for 1862, there are some facts concerning the spectrum afforded by nitrate of didymium. Gladstone had originally found that light, transmitted through dilute solutions of this salt, showed two dark lines in its spectrum. Professor Rood, on causing the light to go through a thickness of 12 inches of a strong solution, found that the spectrum was crossed by twelve distinct bands. The sodium line is cut off by one of these bands, and hence a sodium flame is invisible through this solution, though white objects are but slightly tinted.

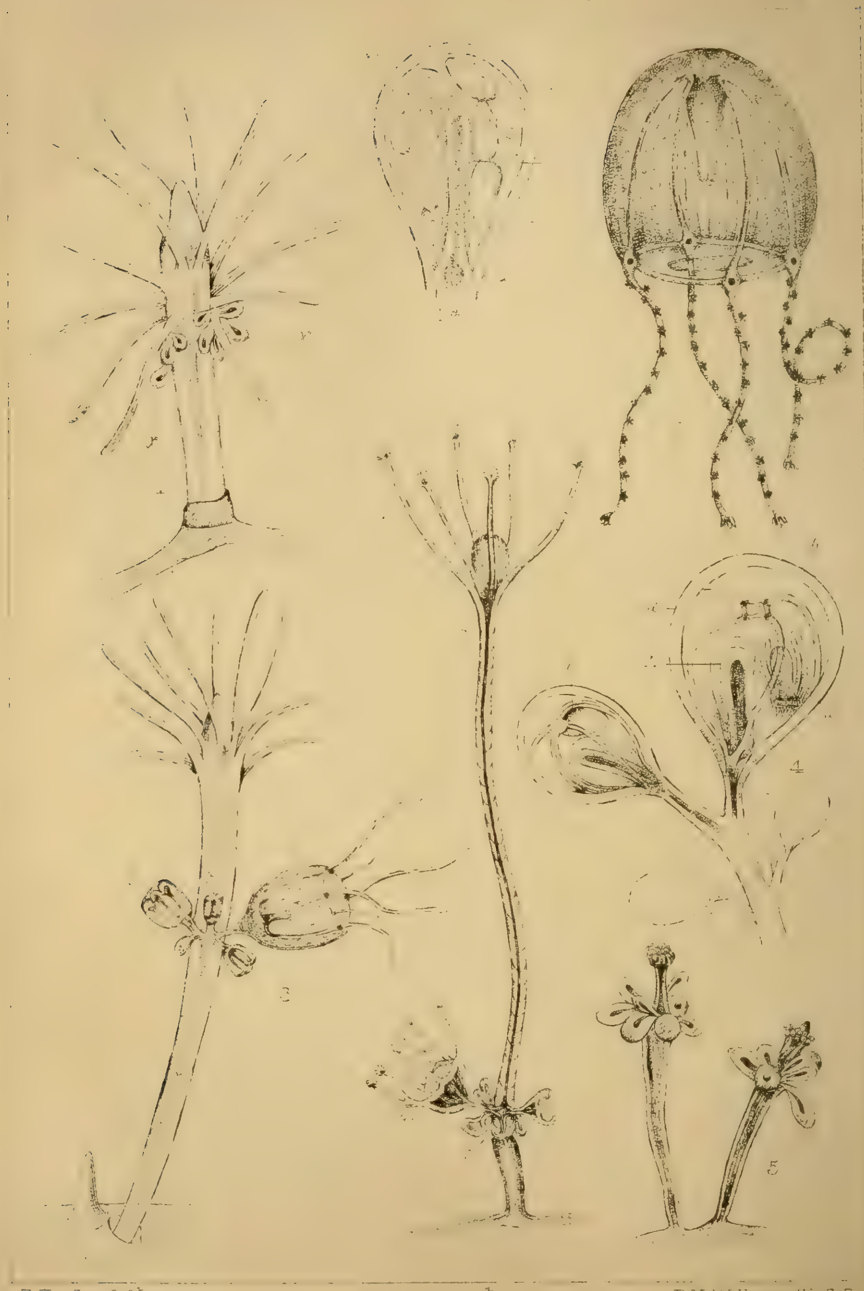
In No. CI., for 1862, Professor Rood describes his spectroscope with four prisms, three of bisulphide of carbon and one of flint glass. He points out a method of avoiding the curvature of the plane glass sides of such prisms, by covering each with a second plane and parallel sided plate, a few drops of olive oil being placed between. With this spectroscope, he found two new lines in the interior of the line D, making three fine lines enclosed in that double line.

In No. CV., for 1863, he points out the advantages of the bisulphide of carbon prism, as compared with the flint prism, an instrument by Merz, the sum of whose refracting angles was 270°, being unable to resolve the line D as completely as one consisting of three bisulphide of carbon prisms of 60° and one flint of 45°, though the sum of the refracting angles was 45° greater. He also insists on the advantage of large aperture.

Professor Cooke's Experiments.—In 'Silliman's Journal,' No. CI., for 1862, the prism made for Professor Cooke, by Clark, is described. It is built up of several thicknesses of plate glass, cemented together with Canada balsam. He describes its defining power, and the appearances presented by the orange band of strontium. It consists of an orange space covered by a large number of black lines, similar to those of Fraunhofer.

In No. CVII., for 1863, Professor Cooke describes a spectroscope, the largest made up to that time. It has nine prisms of bisulphide of carbon, giving $2\frac{1}{4}$ inches aperture, with telescopes of corresponding size. The prisms are made on Rood's plan. The instrument has established the following points:—1st. That the lines of the solar spectrum are innumerable; it shows at least ten times as many as are given by Kirchhoff, with very many nebulous bands on the point of being resolved; the line D consists of nine lines, and a nebulous band. 2nd. That the coincidences of the bright lines of metallic spectra, and the dark lines of the solar spectrum, remain perfect even with this increased power. 3rd. That many of the bands of metallic spectra are broad-coloured spaces, crossed by bright lines. This is the case with the orange band of strontium, and with the whole of the calcium and barium spectra.

Messrs. Johnston and Allen's Experiments.—In No. CIII. of 'Silliman's Journal,' for 1863, they describe the spectrum of cæsium,



T. Hincks, del^t. Hanhart, Imp^t. E. M. Williams, F.L.S. Sc

TYPICAL ZOOPHYTES & THEIR DEVELOPMENT. (Plate I.)

finding it to yield eighteen lines instead of eleven. They also point out that some of Kirchhoff's lines are incorrectly mapped. The cæsium was prepared with the greatest care by precipitation from bitartrate of cæsium, with bichloride of platinum.

Professor Gibbs' Spectroscope.—'Silliman's Journal,' No. CIII., for 1863.—In this instrument, the prism has a refracting angle of only 37°. The rays fall on the first surface perpendicularly, and escape almost parallel to the second. The dispersion is very great, while the loss by reflection at the first surface in prisms of 60°, placed at the angle of minimum deviation, is avoided. Though the telescopes are only of 6 inches focal length, with a magnifying power of 6, it compares favourably with a large apparatus of 18 inches focal length, and $1\frac{1}{2}$ inch aperture. This form of prism was first employed by Mathiessen, and if the first surface is made concave, so as to admit the addition of a double convex of crown, it would present great advantages in consequence of the saving of light.

ZOOPHYTES: THE HISTORY OF THEIR DEVELOPMENT.

By the Rev. THOMAS HINCKS, B.A.

THE remarkable facts which have been brought to light of late years respecting the reproduction of the Hydroid Zoophytes,—an Order of compound, plant-like animals, chiefly marine, of which the Hydra is the type,—facts which at first sight seemed little short of marvellous, and of which we have had so many speculative interpretations, have attracted notice even beyond the ranks of professed naturalists, and have formed the staple of many a scientific romance in the pages of our popular literature. Many who have but a smattering of zoological knowledge will have heard the story, that certain Zoophytes produce offspring totally unlike themselves—beings of dissimilar structure and habit, and that these reproduce the likeness of the original stock; they will have read with wonder, how the stationary, plant-like animal gives birth to a mercurial brood of restless rovers, and that there is a close blood-relationship between the polype and the Medusa. The celebrated theory of the "alternation of generations" may also have interested them as a curious speculation. But as yet the popular apprehension of the whole subject is probably of the vaguest and most inaccurate. It takes the form of a general notion that there are creatures which have not a feature of resemblance to their own fathers or mothers, nor yet to their own children, but which *do* resemble their grandfathers and grandmothers, which exhibit, in short, a complete reversal of the ordinary laws of kindred. The story as thus rendered has certainly enough of marvel and mystery about it to fascinate the mind; but we venture to think that the simple truth of Nature, as now placed before us, through the concurrent labours of many observers, is not less attractive, and we propose, apart from all technicalities, to

give an outline of the later views of the reproduction and development of the *Hydroida*, and to supply the rationale of the facts, which have been made the basis of so much ingenious theory.

Before proceeding, however, to sketch the general characteristics of the group under consideration, we wish to draw attention to the very gradual accumulation of the facts on which our present theoretic views rest, and the way in which we have been led on from point to point by the observations of isolated students, until at length we have attained a true conception of the entire history. In a series of papers by various authors, extending over a considerable period of time, and scattered through the Scientific Journals of Europe and America, are to be found the successive steps by which we have advanced to the point at which the true method of nature was recognized. Some of these, of course, stand out from the crowd, as of pre-eminent merit. But we are anxious to direct attention to the valuable co-operation of those who have conscientiously put on record facts the full significance of which they did not at the time appreciate, but which have formed important links in the chain of evidence, by which the truth has been finally established. In interpreting the reproductive history of the Hydroid Zoophytes, we have been indebted to the suggestive observations of a large number of independent workers for the hints which have guided us into the right track. Gradually a series of facts has been accumulated, the significance of which was only partially, if at all, appreciated at first, but which now supply the basis of a complete and satisfactory theory.

We would commend to those who may have a taste for Natural History, and fair qualifications and opportunities for the pursuit of it, but who may not aspire to any very profound acquaintance with it in its large extent, the careful and conscientious study of single life-histories, as fraught with the highest interest in itself, and almost sure to yield valuable results. In the history of zoophytology, there are names which find an honourable place, and are inseparably connected with its progress, by virtue of one or two observations of undoubted accuracy and striking significance; and amongst the many species of Hydroids, which have not yet been followed through the various stages of their development, there is still ample room for that quiet and patient investigation which is within the range of so many, which is so rich in interest, and which has already done so much for the advancement of the science.

Animal-plant (Zoophyte) is not, after all, a bad popular name for the fixed, compound, and arborescent beings, in which so many of the characteristics of the two great kingdoms of nature are curiously blended. The Zoophyte is an animal in which the vegetative life is altogether predominant, which in its perfect state is commonly as stationary as the tree, and in a large proportion of cases imitates the form and general arrangement of parts that belong to the plant. The compound kinds which often attain a very large growth and are so remarkable for their beauty, are the result, like the tree, of a continued process of gemmation, bud after bud evolving itself and helping to build up the vital structure according to the pattern of the

particular species. Throughout this tribe, we meet with the tendency to an indefinite repetition of similar parts, which is characteristic of the vegetable kingdom, and invariably marks a low grade of animal being.

In the history of the Order to which this paper is more specially devoted, the *Hydroida*, or Hydroid Zoophytes, there are facts which exhibit a still further parallelism to certain phenomena of vegetable life. The plant has its leaf-buds and its flower-buds: the one connected with the nutritive, the other with the reproductive, functions, distinct in structure, form, and position. And the analogues of these exist in the Zoophyte, which not only puts forth its multitude of polypites to secure and prepare food for the commonwealth, but also originates another class of buds, wherein the reproductive bodies are matured, which perpetuate and diffuse the species.

Whilst, therefore, the two organisms belong to distinct kingdoms of Nature, they are connected not merely by similarity of external aspect, but by a certain analogy of life. And some of the most remarkable and perplexing points in the history of the *Hydroida* may be best explained, by collating them with the familiar facts of the vegetable world.*

To gain a clear conception of the structure of the Hydroid Zoophytes, we must start from the common Hydra, the simplest element in the life-series to which they belong. In this historic animal, we have an epitome of the essential characters of the Order: in its life, we have the story of that Order "writ small." It presents us with a gelatinous body of mutable form, the centre of which is pierced by a cavity extending from end to end of it, that communicates at one extremity with the external world through a simple orifice, while at the opposite pole a somewhat expanded disc fulfils the contrasted functions of attachment and locomotion. The terminal mouth is encircled by a number of delicate and extensile threads, which bristle with an armature of minute but fatal weapons (thread-cells) and serve at once for the capture and destruction of prey. This simple structure, submitted to analysis, declares itself to be composed of two essential elements, which enter into every portion of it, and of which its few special organs are but modifications. Two membranes, an outer and an inner—the one in relation with the external, the other with the internal world—constitute the material out of which the Hydra, and all the kindred Hydroids, are wrought. The body is, as it were, a double sac, of which the arms that form a wreath round the orifice, are but tubular prolongations. The double membrane is the basis of Hydroid structure.

The provision for the multiplication of the species is twofold. New individuals are produced in immense abundance by a purely vegetative process. From the surface of the body, just as from the stem of the plant, buds pullulate, and these are rapidly developed into Hydræ, which are perfect copies of the original stock. During

* In his 'Métamorphoses de l'Homme et des Animaux,' chapter xxii., M. de Quatrefages has drawn an elaborate parallel between the structure and reproductive history of the plant and the Zoophyte.

the process of gemmation, and before the termination of the organic connection between the nascent young and the parent, a composite being is formed, and we have thus in a transient stage of the life-history of the Hydra, a representation of that which is the permanent condition of most of the Hydroid Zoophytes. At a certain point of development, the budding Hydræ detach themselves, and enter upon independent existence.

Let us examine the *bud* in its earliest condition, when it appears as a slight excrescence on the side of the body. It is a mere bulging of the double membrane, which forms the wall of the central cavity, a little *cul-de-sac* projecting from its surface, and freely communicating with the interior. This minute, sac-like extension of the two layers is gradually moulded into a perfect Hydra.

But besides the multiplication of this species by means of a gemmiparous process, strictly analogous to the phenomena of vegetable growth, we find also a true sexual reproduction. At certain seasons only, and within certain definite zones on the surface of the body, other buds are produced, which instead of taking the line of development just described, become laboratories wherein the generative elements are matured. These are the analogue of the flower-bud in the plant.

In essential structure they seem to be identical with the early stage of the Hydra-bud. They consist, like it, of a small sac, formed by an outgrowth of the body-wall—a cavity communicating with the stomach of the Hydra, and bounded by the double membrane. In the reproductive bud, however, growth is soon arrested, and it remains a small tubercle on the surface of the body. The generative products—ova or the male element—are developed within it, *between the two membranes*, which they push asunder as they increase in bulk.

Here, then, we have the simplest form of the reproductive system found amongst the Hydroida. But the point to which we would draw special attention is this: we have here the *essential element* of that system, under all the modifications which it presents throughout the Order. Whatever may be superadded, whatever accessory parts may be introduced, the ova and spermatozoa are produced universally within the walls of a body, which is essentially identical in structure and mode of growth with the simple reproductive pouch of the *Hydra*. The so-called Medusa is only such a pouch, somewhat modified, advanced a degree or two in development with a view to free existence, floated by means of a contractile bell, and supplied with a few rudimentary organs of sense.

A series of transition-forms, in which there are now no important gaps, links the simplest condition of the sexual zooid* with the most complex; the closed and stationary egg-bag at one extremity of the scale, with the free mercurial Medusoid at the other, which not only produces, but also distributes the ova.

* This term is used to denote the several distinct elements, which make up the sum total of the individual life-series, *e.g.* the polypites, and the reproductive bodies, whether fixed or free.

We must emphasize this fact. The small bud on the surface of the Hydra's body, which discharges the office of ovary or spermary, is, to all appearance, identical in composition and manner of growth with the bud which is matured into a new individual, in its earliest stage. The Hydra-bud and the sexual-bud start from the same point, and travel together for a while on the same road; but the latter is arrested in its course, and adapted to a special function, while the former reaches the goal of separate individual existence. In other Zoophytes this reproductive bud makes a nearer approach to the Polypite form; and in the kinds which originate free Medusoids, it is even furnished with a mouth of its own, to which prehensile appendages are often attached, and a distinct nutritive system. It is, in fact, in such cases a sexual Polypite, with accessory locomotive organs. Of the *animal plant*, we may well call it the floating flower-bud.

The Hydra is a free and solitary being, and of the simplest structure. Its gemmæ are cast off successively, and prolific as it may be, it is still permanently single. But in other members of its tribe, the budding process has a very different result, a result similar to that with which we are so familiar in the plant. The gemmæ are retained in connection with the original stock, which is itself fixed, and a compound structure is formed, a commonwealth of Hydræ, indissolubly united like the leaf-buds of the tree, and partners in the same life. In these composite Hydroids, a slight modification of the essential elements, as found in the Hydra, produces a very important change in external aspect. The outer membrane excretes a horny covering, that clothes and protects, more or less completely, the soft portions, investing the stems and branches of the arborescent kinds, and in some families expanding into graceful calycles around the associated Hydræ, into which they can retreat for shelter. It is by this covering or polypary that the Zoophytes are best known, for in our museums they are commonly represented solely by the chitinous casts of their elegant and exquisitely-ramified forms.

The compound and plant-like growths, evolved by repeated buddings from a single germ, are often of very considerable size, some thousands of polypites being in some cases united in the one organism, each of which is actively engaged in the capture of prey for the nutrition of the commonwealth. The beauty of these vegetating animals is surpassingly great. They take the form of exquisite plumes, of miniature trees laden with polypites, like milk-white blossoms (which Marsigli took them to be), of clusters of tubes surmounted by vividly-coloured heads, encircled by a double wreath of tentacles, and looking like bright flowers on long and slender stems, of twisted pedicles bearing crystal chalices aloft, in each of which a Hydra displays itself, and casts forth its embossed arms over the crenated border, of a delicate netted stolon creeping over the surface of the sea-weed, and sending up at intervals tiny campanulate cells, fit to be the drinking-cups of fairies. Great is the variety, and great the beauty. But whatever may be the form or size of the Zoophyte, whether its federation number tens or thousands, it has its origin in a

single Hydra, and is the result of a continued process of gemmation. Nutriment is procured for the commonwealth by the labours of the multitudinous polypites, is prepared in their stomachs, as in so many laboratories, and is then distributed to all parts of the structure, through a channel which permeates the trunk and every branch and branchlet. So much may suffice as a sketch of the general character of the tribe. Our present concern is with the reproductive history in which the facts occur that may be said to have a popular interest.

If we were in search of a complete contrast to the staid and stationary Zoophyte in external appearance and in mode of life, we might find it in those exquisite little crystal globes, which, bright and frail as the bubble, dance so gaily through the waters of the sea, and are known to the naturalist as Medusæ. On casual inspection, the two organisms seem to have nothing in common. The one is rooted to a point of space, the other is free of the wide waters, and seems almost to have realized perpetual motion. The one is all but universally compound, the other single. But why speak of differences, when there is not a point of apparent resemblance? Systematists till recently never dreamt of any connection between them, but grouped them in two distinct *Classes*. The observations of Wagner, Sars, Dalyell, Steenstrup, and others which showed that certain Medusæ of the simpler or naked-eyed division are borne as buds on certain plant-like Zoophytes, and are in some sense the progeny of beings so unlike themselves, were a startling surprise. We are now familiar enough with the fact, but have only lately discovered its real significance.

We now know that a very large proportion of the so-called naked-eyed Medusæ, if not all of them, are at one period of their existence in organic connection with some Hydroid stock, from which they bud just as the polypites do, but from which they are also detached at a certain point of their development, and in their free state mature the elements essential to the reproduction of the species, scattering the embryos, the seed of new colonies, at a distance from the original settlement.

Now, to comprehend this history, we must do two things: 1st, we must discard any conceptions we may have formed of the Medusæ as independent organisms—as perfect animals; and, 2nd, we must recognize the essential structural identity of the polypite and the medusoid.

Professor Huxley long ago took exception to the term *Medusa*, as the designation of the free sexual zooid of the Zoophyte, rightly urging that it tended to perpetuate an erroneous view of its nature. It should have a name that expresses its relation to the life-series, of which it is but a single term, and that suggests no thought of positive independence. We believe that it will be better to dismiss both Medusa and Medusoid from our nomenclature, and thus to get rid of the false associations that have gathered round these terms as a nucleus. Professor Allman, to whom we are indebted for an exhaustive report on the reproductive history of the Hydroida, and whose name

is identified with the most philosophical views of the subject, designates the body which gives origin to the generative elements, the *Gonophore.* For reasons with which we need not now trouble our readers, we prefer the term *Gono-zooid*—reproductive zooid—the element, that is, of the Zoophyte, whether fixed or free, which discharges the sexual functions, the equivalent of the flower-bud in the plant. Throughout the remainder of this paper we shall employ this term as thus defined, though by doing so, we shall discharge some of the romantic flavour from our story.

With respect to the second point, the structural identity of the nutritive and the sexual zooids, however different in external aspect, we shall hope to make it apparent in the course of the sketch of the reproductive history of the Zoophyte, which we shall now proceed to give.

We have already seen that in the case of the Hydra, as in that of the plant, two distinct classes of bud are developed, the one concerned in nutrition, the other in reproduction, and the same holds good of the Hydroid Zoophyte. Besides its multitude of busy polypites collecting food, and with no other function, bodies are met with at certain seasons of peculiar structure, which exhibit a true sexual character, and, as Quatrefages puts it, "à qui seuls revient le soin d'assurer la propagation de l'espèce." These reproductive buds present many varieties, — they have their many forms and even colours, like the flower and fruit of the plant,—and they differ yet further and more remarkably in this, that while some of them continue permanently attached to the stock, others, at a certain stage, become free. The latter disguised by the locomotive organs, with which they are furnished for the vagrant term of their existence, and long known to the naturalist, apart from all their connections, are *the Naked-eyed Medusæ* of authors (Plate i. fig. 2). We must not, however, draw too broad a line of distinction between the fixed and the free reproductive zooids. They are both portions of a series, through which indeed "one increasing purpose runs," but also an identity of essential elements.

The fixed sexual bud of the Zoophyte matures and discharges its contents *in situ.* The free zooid, liberated from the parent stock, bears with it the seed of new commonwealths, and colonizes distant seas.

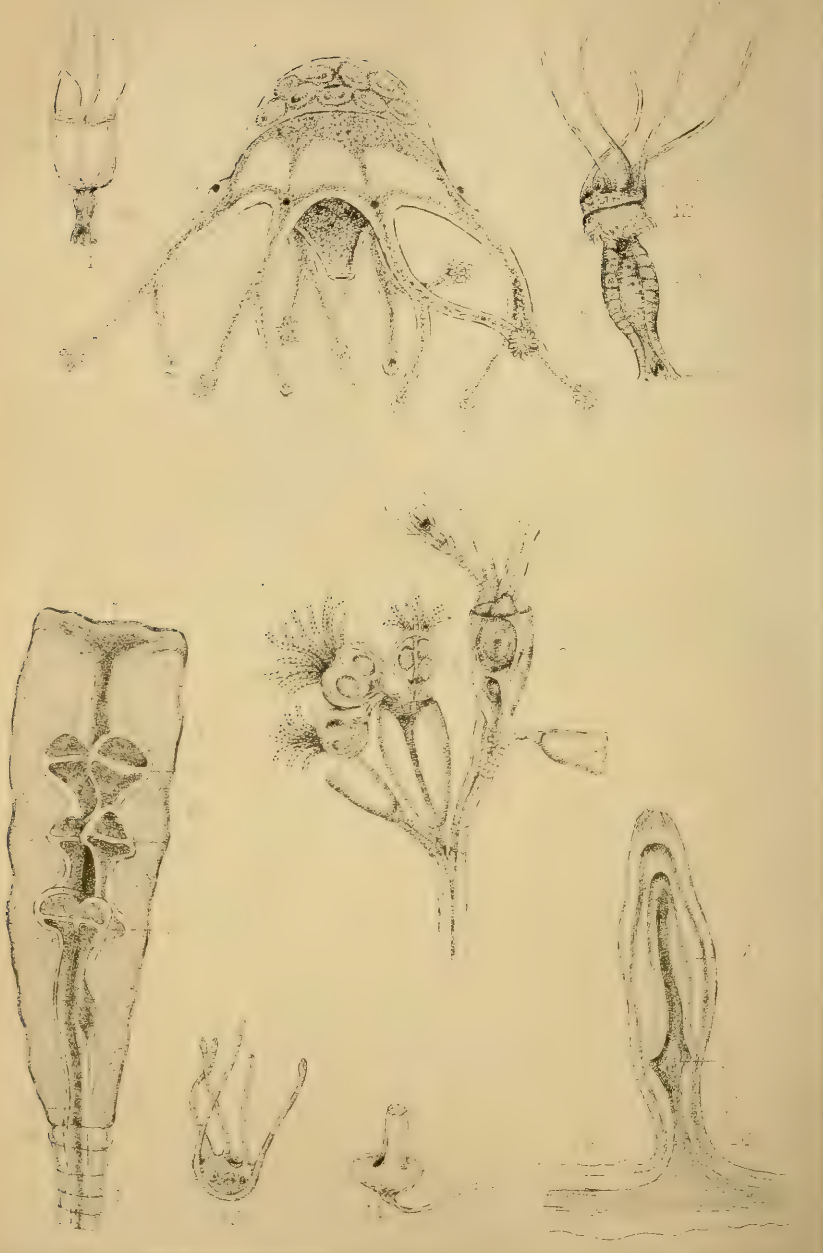
Let us trace the history of these bodies. They are produced on various parts of the Zoophyte. Sometimes they bud from the ordinary polypite and form a kind of collar near the base of its tentacles (Plate i. fig. 1). Sometimes they occur near the lower extremity of the body, pullulating in opposite clusters (Plate i. fig. 6).

In some cases, a partially-developed polypite, one in which growth has been more or less arrested, supports the reproductive zooids (Plate i. fig. 5). Sometimes the atrophy shows itself merely in a reduced number of tentacles ; sometimes the arms disappear altogether, as in the *Hydractinia* (Plate i. fig. 5) ; sometimes it sets in only as the sexual buds approach maturity, and a greater drain takes

place upon the nutritive energies in their behalf, as we have seen it in *Coryne.* In other cases, both mouth and arms are suppressed, and the reproductive bodies bud from the sides of a simple off-shoot from the common trunk. This condition obtains almost universally amongst the Campanularian and Sertularian Zoophytes, and in these tribes the fruit-bearing shoot traverses the centre of a horny capsule, which envelopes and protects the whole brood of sexual zooids, as the ordinary calycle shelters the polypite. In Plate ii. fig. 9, we have a representation of the reproductive capsule of a Campanularian Hydroid (*Laomedea amphora,* Agassiz). The horny envelope (*a a*) is supported on a short ringed pedicle (*b*), by which it is attached to the Zoophyte at the base of the longer stalks, which bear the cells of the polypites (*Hydro-thecæ*). From one extremity of the capsule to the other passes the off-shoot (*c c*) from the common pulp, on which the reproductive buds or zooids are borne (*d*). This shoot is plainly a Hydra, arrested in its development before the formation of a mouth and tentacles, and dependent for food on the supplies which are brought to it by the general nutritive stream, which circulates, like the water through a town, to every part of the colony, and which enters it through an orifice at the base. It would appear, in some cases, to declare its essential nature by developing the missing parts and assuming the perfect polypite form, when the reproductive bodies have run their course and discharged their contents. Ellis at least figures Hydræ protruding from the capsules of *Sertularia pumila*, and we have had no more trustworthy observer. For this imperfect polypite, whether naked, as in the *Hydractinia* (Plate i. fig. 5), or enclosed, as in the case before us, a special name has been invented, and in conformity with the present unhappy fashion, it is a Greek compound of six syllables—*Gonoblastidium,* or in a mitigated form, *Blastostyle!* We venture to protest against this infliction, as both unnecessary and in some degree deceptive. The mouthful of Greek, which may well set the teeth of the young or unlearned naturalist on edge, is more likely to divert attention from the real significance of the body in question than to help the student to interpret it aright. Who would venture to recognize a familiar friend in a Gonoblastidium? In fact, it is a fertile polypite—a Hydra which bears the sexual buds, and is somewhat enfeebled by the work,—and why, in the name of common sense, should this intelligible designation be translated into Greek or any other learned language?

The reproductive buds are also developed, in some species, on the stem and branches, and rarely on the creeping stolon, which originates and unites the several shoots that compose the Zoophyte.

And now a word as to the nature of the buds themselves. In the first place, they are male and female—one set giving rise to the ova, and another to the spermatozoa. Sometimes the two sexes are borne on the same colony; sometimes, and more commonly, the male and female zooids occur on separate colonies. The Zoophyte, like the plant, is diœcious or monœcious; and the latter condition is of more frequent occurrence than has been supposed. Professor Allman gives one or two instances of it as strictly exceptional, but we have met



TYPICAL ZOOPHYTES & THEIR DEVELOPMENT. (Plate II.)

with some other cases, and probably careful investigation might increase the number.*

In Plate i., fig. 1*a*, we have a good illustration of one of the simplest forms which the reproductive bud of the Zoophyte assumes. It is a highly magnified representation of one of the bodies that are shown *in situ* in Figure 1 (x—x), and it is at once apparent that it exhibits a very slight advance upon the simple egg-pouch of the Hydra. It is a narrow sac, formed by an outgrowth of the body-wall. The central cavity (*a*) is in free communication with the stomach of the polypite, and is visited by the common nutrient stream. It is enclosed by the inner of the two membranes (*b*), that we have described as the basis of all Hydroid structure, from which the outer (*c*) is separated by a mass of ova. Essentially this is the sexual bud of the Hydra over again. The latter, indeed, is of small dimensions, and contains but a single ovum, which, as it enlarges, soon presses down the inner membrane, and obliterates the central cavity, but the component elements are the same in both. The differences between them are of very slight significance. They amount to nothing more than this, that in the present case, the external membrane is divided into two layers, the outermost of which serves as a protective capsule (d—d), and the bud is elevated on a kind of pedicle. To convert this Gono-zooid into a *polypite*, little change would be needed. With an orifice at the upper extremity, and a few tubular prolongations of the sac around it, or scattered over the surface, and *minus* its capsular investment, it would be a very respectable Hydra. Before the differentiation of the ova, it is all but identical with a polypite-bud in its early stage.

In the Campanularian capsule (Plate ii. fig. 9), the sexual zooids (d—d) are of a still simpler character, and make a yet nearer approach to those of the Hydra. Each of them contains only a single ovum (*e*), which, as it increases in size, occupies nearly the whole of the sac, the inner wall (*e*) being pressed down towards the bottom of it, and forming "a shallow, saucer-shaped basis for the egg." In the male zooid, however, the central cavity is large, and projects far into the enveloping mass of spermatozoa. The sexual bud of the Hydra is in all these points identical with that of the Campanularian† before us, which Agassiz describes as "nothing more than a double-walled hernia;" and yet, from the capsules of a Zoophyte nearly allied to this, of much the same structure and general aspect, we may witness the escape of those Medusa-like organisms to which so much interest has attached. So that within the limits of a single family, and in its most nearly allied species, we find the most widely-separated forms, the simplest and the most complex, of the reproductive zooid.

* We have met with male and female capsules together, on *Halicornaria* (*Plumularia*) *Catherina*, on which they are thoroughly intermingled; *Sertularia tamarisca* and *S. fallax*, and (we believe) on a species of *Halecium*. The *Hydra* presents us with both conditions, being sometimes monœcious, and sometimes diœcious, representing its Order in this, as in so many other points.

† *Vide* a paper by Hancock, "On a species of Hydra found in the Northumberland Lakes." Ann. Nat. Hist., vol. v., 1850.

It is our business now briefly to trace the connection between the two—to show that the one extremity of the scale is united to the other by a series of intermediary forms, and *that there is the same essential element in all.* We have to link the fixed bud that vegetates and liberates its germs, and then withers away on the spot, where it came into being, to the winged and freighted seed-vessel, floating far and wide through the waters.

Let us pass then at once to the free Gono-zooid (the *quondam* Medusa), and examine its structure. We have a representation of it, while still attached to the Hydroid stock (Plate i. fig. 3*a*); and after liberation (Plate i. fig. 2). In its former state, it is connected by a pedicle with the body of the polypite, which springs from the midst of a cluster of buds in various stages of development. We might naturally take it to be a permanent portion of the colony, a bud of peculiar structure, and destined for some special function, but not more remarkable amongst the polypites than the flower-bud amongst the leaves on the plant. Such, however, is not its history. After a while it dissolves its connection with the polypite, and thenceforth leads an independent existence. By a reference to Plate i. fig. 2, the reader will obtain an idea of the general form and structure of the free Medusiform zooid. A somewhat globose and transparent disc floats gracefully in the water, and within the cavity a cylindrical body hangs from the central point of the dome—a rose-coloured pendant in a crystal sphere. The disc or umbrella is truncate below and partially closed by a filmy membrane or veil, in the centre of which there is an oblong aperture. From its margin depend four extensile and beaded tentacles, which take their origin in as many bulbs, on each of which a rose-coloured ocellus glitters. From the base of the pendant body four tubular canals pass through the substance of the disc to these bulbs, where they join a circular vessel that runs round the margin, and connects them all. The disc, which is the striking feature of the structure, is a float and swimming bell, and by means of its rhythmical contractions the zooid is jerked backwards through the water. The pendant body is furnished with an orifice at its free extremity (the mouth), which admits to a central cavity, and this communicates at the base with the four canals, and through them with the circular, marginal vessel. We have here the nutritive and circulatory systems. The tentacles are fishing-lines, and the *ocelli*, it may be, rudimentary light-perceiving organs.

In time ova or spermatozoa, as the case may be, are developed *between the two membranes* which constitute the walls of the pendant body (Plate ii. fig. 12*a*)* and when these are matured and dis-

* This figure represents the pendant portion of a Gono-zooid apart from the swimming-bell, with the ova developed in the walls. It is proper to mention here that in certain families the generative elements are not produced in this situation, but in small sacs, which bud from the radiating canals. These canals, however, we must remember, are but prolongations of the central cavity, so that the reproductive bodies are still in connection with (essentially) the same portion of the structure. The difference is that in this case instead of lying between the two layers which compose the wall of the canal, the generative products are contained in sacs, which bud from them, and which are similar in structure to those of the *Hydra.*

charged, the zooid having fulfilled its functions appears soon to perish.

This sketch may suffice to give an idea of the *plan of structure* which characterizes this class of buds. Of course there are many diversities. The colours, the form of the disc, the number of the canals, the shape of the pendant, the number and structure of the tentacles, all these vary, while in some species there are additional organs of sense on the margin. But the plan of structure is constant.

To describe the several parts of these animated seed-vessels is an easy task, but it requires the pencil of the artist and the pen of the poet to do full justice to their beauty. Let any one who would realize it glance over the plates in Professor E. Forbes's Monograph on the (so-called) "Naked-eyed Medusæ." He brought the skill of the artist, and the fancy of the poet to the illustration of their history, and he has well epitomized their characteristics in saying that "they are active in their habits, graceful in their motions, gay in their colouring, delicate as the finest membrane, and transparent as the purest crystal."

Now at first sight, these floating bodies seem to have little in common with the fixed buds which we found discharging a similar function on the side of the Hydra, and within the reproductive capsule of the Campanularian.

But if we put out of view for the moment the portions of structure which have immediate relation to independent existence, the swimming-bell and its appendages, we shall have as the residuum a body which is essentially identical with these buds. The central pendant of the Medusiform zoid is represented in this condition in Plate ii. fig. 12—the disc having collapsed, and the remains of it (*b*) with the tentacles attached, hanging from the base of it. The disguise being thus got rid of, we recognize at once the structure with which we are already familiar—a bud presenting a central cavity (*d*) enclosed by the two membranes, between which ova are developed. True there is an opening at the extremity (*e*), but this also is connected with the necessities of free existence, the zooid being dependent in this stage of its being on supplies from without, and no longer nourished by the commonwealth. Suppress the mouth, and the body which we are examining is identical (essentially) with the sexual bud of the *Hydra*, of the *Clava* (Plate i. fig. 1*a*), *minus* the protective envelope (*d*), and of the *Campanularian* (Plate ii. fig. 8*d*.)

The accessory and adaptive organs then, which fit the sexual bud in some cases for a term of free existence, constitute the difference between its simpler and more complex forms. The ova- or sperm-bearing body, which is the essential element, is constant and structurally identical throughout the Hydroid series. In the case of the Medusiform zooid it exhibits an advance of development, is furnished with a mouth, and becomes a true polypite, a polypite combining the nutritive and reproductive functions. The (so-called) Medusa is a sexual Hydra (male or female), suspended within a contractile bell, which bears it through the water. The vivid tints which it often displays both on the disc and the peduncle, the gracefulness of its forms,

and the exquisite delicacy of its tissues may well remind us of the flower of the plant, with its painted petals, and campanulate corolla, and central mass of colour; and if the flower-bud were in any case set free to float in the air, and there distribute the seeds matured in its ovary, it would be the exact analogue of the locomotive bud of the zoophyte.

A study of the earlier stages in the development of this body will confirm the view which we have given of its nature. It is at first an outgrowth of the body-wall, an extension of the two membranes, including a small sac-like cavity. It is identical with a Hydra-bud. The outer layer, as we have seen in the case of *Clava*, divides, and an external covering is formed, within which the development of the bud proceeds (Plate i. fig. 3*b*). We shall not follow in detail the changes which supervene, but merely state generally, that the same layer is again split into two, and that the bud instead of continuing simple, and maturing and discharging its products *in situ*, is invested by the membranous envelope thus formed, which becomes the swimming-bell in time, and at length bears it from the stock. When the bud has reached a certain point of development, its outer enveloping sac is ruptured, and it bursts, as it were, into flower; the Gono-zooid now nearly perfect, and ready for freedom, hangs on its slender pedicle (Plate i. fig 3*a*), until by the vigorous contractions of the disc the frail bond is severed and it floats away.

To complete this portion of our subject, it is only needful to pass in rapid review some of the intermediate forms or conditions of the reproductive zooid, which connect the two extremities of the developmental scale.

(1.) It sometimes takes on the contractile swimming-bell, and to all appearance is on the usual road to separate existence, but is arrested before reaching the goal, and remains a *fixed* Medusiform bud. The central peduncle behaves like any simple reproductive sac, and discharges its products, where it is. In such cases the tentacles are rudimentary, and the mouth also, if present at all.*

(2.) A somewhat lower stage is met with in the common *Tubularia indivisa* of our coasts. In this zoophyte the sexual bud (Plate ii. fig. 4) is permanently attached, but it is furnished with the umbrella (*b*) in which the canals are present, and the orifice, with four tubercles, representing the four marginal tentacles. The generative sac (*c*) destitute of a mouth occupies the centre. There is every preparation for free existence up to a certain point, but the bud remains to the end packed up in the outer sac (*a*) and the swimming-bell is converted into a chamber or nursery, in which the embryo (*d*) completes its development, escaping at last through the orifice above.

(3.) In the remarkable Campanularian Zoophyte the *Gonothyrœa Lovéni*, Allman (Plate ii. fig. 8), we have another modification of the

* Lovén first described this form in his famous paper, entitled 'Bidrag till kännedomen af Slägtena Campanularia och Syncoryna,' published in 1836; and he speaks of the peduncle in his *Syncoryna ramosa*, as possessing "an exceedingly small mouth,"—"*en ganska liten munn omgifven af omkring tio smä tuberkler—rudimenter till munntentakler.*"

process. The figure represents a portion of a shoot, on which both polypite-cells and reproductive capsules are present. In one of the former (*a*) the Hydra is seen retracted within its transparent dwelling. *b* and *d* are two of the *Gono-thecæ*—the horny receptacles within which the sexual buds are developed, as in Fig. 9. At *d* one of them is represented within the capsule, attached to the axial column, which we have before described, as an imperfectly developed polypite. While in this position it exhibits the central reproductive sac (*the essential element*), surrounded by two investments, the inner representing the swimming-bell, with canals and an orifice, and a number of tentacles, but no contractility, the outer being the usual protective case. The generative elements are produced between the walls of the sac—but the ova, at least, soon rupture the outer one, and complete their course of development within the more spacious area of the swimming-bell. But there is this peculiarity in the history of the sexual buds of this species,—at a certain stage they are pushed out beyond the mouth of the capsule, where they hang like fruit (Plate ii. fig. 8, *c*, *c*, *c*), until the seed has ripened and escaped, when they wither away.

(4.) In yet another case, Prof. Allman has detected in a sexual bud like that of *Clava* (Plate i. fig. 1*a*) in most respects, the membrane which represents the swimming-bell interposed between *d* & *c*, but forming merely a closed sac—one more envelope around the ovary—while at its base (a clue to its real significance) are the rudiments, the beginnings of four tubular canals. From this point a single step carries us to the simplest form of bud—*the polypite body*, slightly modified, which bears in its walls the sperm or the ova.

We must not omit to mention that the free Gono zooid, though parting from the parent stock and renouncing its stationary life, retains the vegetative tendencies of its tribe, and, in many cases at least, multiplies itself by budding. Its buds, indeed, are cast off like those of the Hydra, as becomes a free being, but it preserves the customs of its race.

Our sketch of the reproductive history of the Hydroida would be incomplete, if we did not add some further illustration of the structural identity of the nutritive Zooid—the Polypite, and the Gono-zooid. Different as they are in external aspect, they are fundamentally the same. This has been partially apparent in the course of our review of the various grades of the sexual bud. We have easily recognized *in the generative sac* the equivalent of *the body of the polypite.* But we owe it to Prof. Allman's keen insight into homological relations, that we can also identify *the radiating canals*, with *the tentacles of the polypite*, and so complete our interpretation of the reproductive zooid. He reminds us that the tentacles are tubular prolongations of the central cavity of the Hydra, just as the canals are of the peduncle of the Gono-zooid, and that we have only to suppose them to be united for a portion of their length by a membrane,* the remaining portion hanging free beyond its margin, to have a structure essentially iden-

* The tentacles of the Polypite are actually thus united in one or two species of Hydroid.

tical with that of the so-called Medusa. This membrane is a growth from the outer of the two fundamental layers of the body-wall and is contractile, when the zooid is to be locomotive. It constitutes a web uniting the tentacular canals, and thus forming a somewhat campanulate disc, while an extension of its margin gives rise to the veil, which partially closes the swimming-bell below. *The portion of the body of the polypite in advance of the tentacles* is the equivalent *of the generative sac* of the Gono-zooid.

We have no intention of troubling our readers with the evidence in detail on which this view rests; but would merely state, that it is sustained by a careful examination of the development of the Gono-zooid, and by many collateral proofs. The generalization to which we are led will have more popular interest. It is this: the reproductive zooid of the Hydroid is in all cases a modified polypite. In its simplest condition it is a polypite without mouth or tentacles; in its highest, it is a polypite with both,—the tentacles, however, being adapted to the formation of a nutritive and locomotive system, with a view to free existence. The two extremes are connected by a multitude of intermediate forms. The so-called Medusa is a sexual polypite, with its arms webbed for floating and swimming.

A very interesting connecting link between the nutritive and sexual bodies in the Hydroid commonwealth is found in the free Gono-zooid of the *Clavatella prolifera*, Hincks (Plate ii. fig. 7). A representation of the polypite of the *Clavatella* is given in Plate i. fig. 6. A cluster of the reproductive buds (*y*, *y*) is seen pullulating from a point near the base of it.

The Gono-zooid of *Clavatella*, though free and locomotive, is not furnished with a swimming-bell—or rather this organ is present only in a latent condition. It is a walker and climber, not a swimmer. It moves by means of sucking-discs attached to the extremity of a branch or fork of the arms (Plate ii. fig. 7*d*). The true tentacle terminates in an enlargement (*c*) which is thickly set with thread-cells. That the membrane which in other species constitutes a swimming-bell exists, we infer from the presence of the radiating canals,* which may be seen passing to the base of the arms (Plate ii. fig. 7). But it is not separated from the body, and is useless for locomotive purposes. As the zooid walks, the mouth (*b*) hangs downward, as it does in the swimming forms. At the base of each of the arms is an ocellus or eye-speck (*e*, *e*). We recognize, in short, in this form, a Medusiform zooid, without its swimming-bell, but with a compensation for the loss in the shape of suctorial feet. As readily do we recognize in it a polypite, with very slight modifications. Let the reader refer to Plate i. fig. 6, and compare the head of the *Clavatella* with its free zooid, and he will see at once that very little change is needed to convert the one into the other. Let him suppose the head to be detached at a point nearly opposite to Fig. 6, and the lower portion of the arms to be united by a membrane

* These were first detected by Krohn. See Wiegmann's 'Archiv.' for 1861, p. 157.

closely investing the base of the proboscis, and their upper portion to be furnished with a sucker-bearing fork, and he will have the sexual polypite. As we have remarked elsewhere,* there is the closest resemblance between the two, the arms of both "exhibiting the same number of opake-white patches, and in precisely the same positions." The Gono-zooid of *Clavatella* is an ambulatory polypite, with the simple circulatory system, and the eye-specks, which are needful to it as a free being.

Agassiz, in his great work on the 'Natural History of the United States,' describes the fixed reproductive bud of a Hydroid (*Rhizogeton fusiformis*, Agass.), † as being developed into a polypite, after completing its sexual functions, and he considers this the most direct evidence thus far obtained of the structural identity of the two bodies. (Vol. iv. p. 226.) Prof. Allman regards the phenomenon as abnormal; but even so, it is not the less important evidence.

One other class of facts may be mentioned in this connection. In some cases, at least, the Gono-zooid, after a term of free life, returns to a stationary condition before the liberation of the ova. The locomotive energy fails, the delicate swimming-bell is thrown back and turns inside out (Plate ii. fig. 11), gradually it collapses and shrinks up into a shapeless mass, hanging in this condition about the base of the body, with the tentacles streaming behind it (Plate ii. fig. 12). The disguise is now thrown aside, and the polypite remains, laden with ova (*a*). It continues quiescent until they are discharged, and after this fades away.

Dujardin describes the Gono-zooid of a species of *Stauridium*, as thus casting aside its locomotive apparatus when its course was nearly run, and resuming the sedentary habits of its tribe, and his observations have been confirmed by Mr. Holdsworth. We have seen the same thing in the case of a *Coryne* and of the *Podocoryne*, and Mr. Peach has reported to the like effect of the latter.‡ We believe it to be the normal course in these cases.

* 'Annals of Nat. Hist.' for February, 1861.

† Plate ii. fig 10.

‡ Vid. Ann. Nat. Hist. (2nd ser.) vol. xviii., 1856, p. 99. Mr. Peach supposed that in this case the polypite was metamorphosed into the Medusoid. But there can be little doubt that this was an error. From an examination of his figures and description, we are convinced that he had a species of *Podocoryne* before him, closely allied to *P. carnea*, if not identical with it, the four leaf-like appendages on which delicate arms were sometimes seen, being the attached Gono-zooids, and the four filiform appendages, the tentacles, which are often few in number, on the prolific polypites. In the case referred to in the text as having come under our own observation, the Gono-zooid did not perish even after the liberation of the ova and the disappearance of the peduncle.

The remains of the swimming bell (pl. ii. fig. 12 b) sloughed away and the bulbous bases of the tentacles (*c*) were fused into a single mass, of hemispherical form, and orange colour, around which an ectodermal covering formed (pl. ii. fig. 13 c).

The specimens continued free in this condition for a time, the arms being in frequent motion. At last some of them became attached by the base, round the edge of which a thin rim of transparent matter appeared, most of the arms withered away, and in one or two instances an ascending shoot sprouted in the centre of the orange disc (Pl. ii. fig. 14). Further than this, we were unable to follow their

We have thus passed in review the various elements of the Hydroid life-series, and endeavoured to supply their interpretation, and to exhibit their mutual relations. We have traced the sexual bud from its simplest to its most complex form, distinguished between its essential and accessory parts, and shown that it is in all cases a polypite structure modified for the special reproductive office. We have collated the nutritive and sexual zooids, and shown that even the so-called Medusa, unlike as it looks, is structurally identical with the polypite, the elements of which are adapted in it to subserve a different function. And we have sought and found a key to many of the most remarkable passages of the history in the analogies of the vegetable world.

And if some of the *marvel* has seemed to vanish as we have proceeded, we venture to think that the real romance of Nature is more than an equivalent for the loss.

There must always be a certain fascination in a history which tells us of animals composed of multitudes of individuals (zooids) living an associated life, and so combining as to produce the most graceful, plant-like structures, vegetating like a tree, putting forth thousands of polypites like leaves, each a provider for the commonwealth,—putting forth also a company of buds charged with the perpetuation of the species, ripening in transparent urns, and scattering their winged seeds broadcast, or sent forth, moulded and painted by the highest art, like fairy emigrant ships, freighted with young life, to colonize distant seas. And these are the simple facts of Nature.

We have often had occasion in the course of this article to refer to Professor Allman's labours in this department of Natural History, and to the important contributions which he has made to our knowledge of the *Hydroida*. These it would be impossible to over-estimate. At the same time, we confess that some of the views propounded by our distinguished friend fail to satisfy us.

His classification of the Gono-zooids under two divisions, to which he has given Greek names, which we omit, lest the general reader should forswear our favourite science on the spot, appears to us unnecessary, if it be not misleading. The various modifications of the reproductive system pass one into another almost insensibly, and any line drawn to bisect the series must be purely arbitrary. To separate the more distinctly Medusan forms (so called) from the simpler is to run the risk of creating a false impression as to the relations between

history; but to all appearance a polypite was in course of development. An account of these observations was presented to the Nat. Hist. Section of the Brit. Assoc. at the meeting for 1864.

Since the passage in the text was written we have seen a paper by Prof. Allman in the June No. of the Annals of N. H., in which he describes "the retrograde metamorphosis of the Medusa into the polypite," in the case of a new *Syncoryne*, which he has discovered in Scotland. Curiously enough the Gono-zooid of this species seems to be almost, if not absolutely, identical with that of the *Coryne eximia*, in which we had previously observed the same change, and which, in its turn, we have shown to be identical with that of the *Stauridium productum*. These facts would lead us to a very interesting chapter of the history, upon which, however, we have not space to enter at present.

the two classes. The boundary, on one side of which is found the Gono-zooid of *Tubularia indivisa*, with its fully-developed swimming-bell, exhibiting canals, an orifice, and even slight contractility, and on the other, the Gono-zooid of *Coryne gravata* (Wright), or *Syncoryna ramosa* (Lovén), with rudimentary mouth and tentacles, and which never becomes detached, can only be regarded as purely artificial. We believe that it is wiser in all respects to maintain unimpaired the continuity of the series, and not to break, for purposes of convenience or otherwise, the chain of links which connects the lowest form with the highest.*

Again, Professor Allman long ago enunciated the doctrine that the *fixed sexual buds* of the Hydroida possess in all cases "a true Medusal structure in a more or less degraded or disguised condition;" and in his recent report he lays it down that "the closed generative sac of a *Clava* (*vide* Plate i. fig. 1a), or a *Hydractinia* (Plate i. fig. 5), is an easily understood modification of a Medusa." But why this way of putting it? "*Medusal structure*" is modified polypite structure. The fundamental element, as it were, of the Hydroid life-series is the polypite, as the leaf of the life-series of the plant. It is this element which is "disguised" in some portions of the reproductive scale, and which it is at times somewhat difficult to recognize beneath its adaptive dress. We should reverse Professor Allman's proposition, and say that the (so-called) Medusa is a modification of the "closed generative sac of the *Clava*," or rather of the polypite, of which the latter is itself an adaptation. And instead of tracking "Medusal structure" amongst the disguises of the reproductive system, we should rather start from the simple element which constitutes the common base of the Hydroid organism, and trace the gradual evolution from it of the more complex forms which culminate in the free sexual zooid. With this view we most truly interpret the facts which are actually before us; for the polypite element is recognizable from one end of the series to the other, but the reproductive sacs of *Clava* and other Hydroids are without a trace of Medusan structure, and to say that this structure exists in them in "a degraded or disguised condition," really means no more than to say that the statue exists in a degraded or disguised condition in the block of marble. Professor Allman would recognize the "Medusal" element throughout the reproductive series; we, on the contrary, would rather recognize the polypite everywhere, and dropping altogether a term which *seems* at least to imply an essentially distinct mode of structure, we should say that the Gono-zooid of the Hydroid Zoophyte is a Hydra more or less modified for the discharge of the sexual functions—attaining in its highest form a free existence, and becoming locomotive by the conversion of its tentacles into a natatory organ.

The whole subject under many of its aspects is one which must have an interest for the general reader, though he may not be willing to undertake the study of a new language for the sake of it. It has been our simple object to translate the later views of the development

* Professor Huxley has taken the same view in his great work on the 'Oceanic Hydrozoa,' p. 137.

of the Zoophytes out of technical phraseology and Greek compounds into as plain English as the subject will permit, and with such comment as our own studies might supply—*pro bono publico.*

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. A polypite of *Clava.* *x*, *x*, Clusters of reproductive buds.
Fig. 1a. The female generative Sac of *Clava*, highly magnified.
Fig. 2. The free Gono-zooid of *Coryne eximia.*
Fig. 3. *Podocoryne carnea*, Sars.
Fig. 4. Reproductive Sacs of *Tubularia indivisa.*
Fig. 5. *Hydractinia echinata*, Fleming,—fertile polypites.
Fig. 6. *Clavatella prolifera*, Hincks.

PLATE II.

Fig. 7. The ambulatory Gono-zooid of *Clavatella.* f, the ovary.
Fig. 8. *Gonothyræa Lovéni*, Allman.
Fig. 9. The reproductive Capsule (*Gono-theca*) of *Laomedea amphora*, Agassiz. From the figure in the "Contributions to the Nat. Hist. of the U.S." Vol. iv. plate xxx.
Fig. 10. The fixed Gono-zooid of *Rhizogeton fusiformis*, Agassiz.
Figs. 11–14. Gono-zooid of *Podocoryne carnea.*

ON THE NEW RED SANDSTONE AS A SOURCE OF WATER SUPPLY FOR THE CENTRAL TOWNS OF ENGLAND.

By Edward Hull, B.A., F.G.S. Of the Geological Survey.

Those who are anywise acquainted with the internal economy of towns and cities in our small and densely-peopled Isle, are aware of the increasing importance of a permanent supply of good water. Session after session, corporations, companies, and commissioners come before Parliament for powers to carry out schemes of water-supply, not only for places already inhabited, but for those whose destiny as such, at no distant day, is clearly foreshadowed by the growth of the neighbouring town. Railways often cause the Fates to spin the wheel with unusual celerity—and the supply beforehand of abundance of pure water is an additional motive power—hence in a few years a houseless suburb becomes in itself a flourishing town.

In former times, even without going so far back as the days of Goldsmith, when there were such things as villages in the central parts of England, every large house had its well, and a mighty pump placed in the centre of the village supplied the wants of the poor. In other cases a gurgling brook ran by the houses, singing merrily—

> "Men may come, and men may go,
> But I go on for ever ;"

and freely giving-of its waters for household use; but now that the villages have grown (or are growing) into towns, and towns into cities, whose inhabitants are counted by hundreds of thousands,—these ordinary sources of supply are becoming obsolete and useless from contamin-

ation; the brooks have been turned into pestiferous sewers—the wells have either dried up or become poisonous;—and the evil through generations of neglect has reached such gigantic proportions, that even Parliament refuses to deal with it.

Private companies, also, which have heretofore been depending to some extent on neighbouring streams, are now forced to extend the bounds of their area of collection to greater distances, or to sink wells, where the geological structure of the district will admit of them, to great depths, and apply powerful machinery. The Birmingham Water Company is a case in point. Hitherto the company have been deriving their supply from the brooks and wells, but this year they have found it necessary to come before Parliament and ask for powers to enable them to extend their area of collection. In his evidence, Mr. Hawksley, the consulting engineer of the company, stated that they were making provision, by the sinking of additional wells, for ultimately abandoning one of their present sources of supply—the tributaries of the river Tame, which there was every prospect would become unfit for drinking purposes, owing to the spread of buildings and factories in the neighbourhood.

Happily for the prosperity of our great towns, Nature offers a remedy for some of the evils alluded to: our country possesses its mountain ranges on the one hand, and wide-spreading tracts of water-bearing formations on the other, and there are few towns of importance, at least in the Central and Northen Counties, which are inaccessible to one or other of these sources of water-supply. In the one case, the mountains receive the rainfall on a surface nearly free from hurtful impurities, and thence it is formed into brooks and lakes; in the other, the rocks gather and imbibe a portion of the rains, and retain it until raised again to the surface by mechanical appliances.

Of the several water-bearing formations of England, the Chalk and the New Red Sandstone are by far the most important, the former occupying parts of the South and East of the country; the latter parts of the Midland and Northern Counties; with this we are only here concerned, except that we may remark that of the two formations the Chalk occupies by much the largest area; while from its situation it receives proportionately less rain on its surface than the New Red Sandstone, so that the actual quantities imbibed by each, *ceteris paribus*, may not be very different. In each case the formation is homogeneous; is of considerable thickness; occupies large areas of country, and is easily permeable to water. These are the essential qualities of all water-bearing formations of any pretensions.

Confining our attention to the New Red Sandstone (or lowest division of the Trias), we shall notice in order the above characteristics upon which its capacity for retaining and yielding large quantities of water depends.

And first as regards its homogeneity, or uniformity of mineral composition (we use the term merely as it applies to our present inquiry), there are doubtless different members, some slightly harder and less porous than others, but the whole formation is essentially a sandstone or conglomerate, rarely containing bands of clay or shale, and hence, whatever water falls on its surface, finds no barrier to its

vertical descent beyond the density of the rock itself. What is true of the rock as regards the facility of vertical percolation is true also of lateral, so that in general the formation may be considered permeable in every direction. The late Mr. R. Stephenson, whose views on this question time and experience have only served to confirm, in his Report on the Supply of Water to Liverpool, says, "My opinion is, that on considering the question of the supply of water, the rock (New Red Sandstone) may be looked upon as almost equally permeable in every direction, and the whole mass regarded as a reservoir up to a certain level, from which whenever wells are sunk water will always be obtained more or less abundantly." Such qualities are obviously of the highest importance, because they enable a well of sufficient depth *to draw* from long distances around, and thus to yield a large supply. Thus the Green Lane Well, east of Liverpool, which by sinking and boring reaches a total depth of 385 feet, and yields upwards of three millions of gallons per day, is stated by Mr. Duncan, the resident engineer, to have influenced wells several miles distant.

In the Midland Counties the formation consists either of a soft variegated sandstone, or of a quartzose conglomerate, both nearly equally porous, and available as sources of water-supply; and of these large areas occur in the neighbourhood of Birmingham, Stafford, Wolverhampton, Kidderminster, Derby, and Nottingham.

The second important feature of the New Red Sandstone is its great vertical thickness, especially in the counties of Cheshire, Lancashire, and Salop, where it is over 1,000 feet. In the Central Counties the thickness is less, and in the eastern parts of Leicestershire and Warwickshire the rock thins out altogether. This thinning away of the formation takes place from North-west to South-east, and may be thus expressed:—

	Thickness in Feet.
Lancashire and Cheshire	1,200 to 1,000
Derbyshire, Staffordshire, Nottinghamshire .	600 to 150
Warwickshire and Leicestershire . . .	150 to 0

Hence it will be observed that there are parts of the country where these water-bearing beds do not exist, and this is the case under Rugby.

With such a vertical development in the Central and Northwestern Counties, we may conclude there is a somewhat proportionately large horizontal area exposed to the rain-fall; but another consequence is the vast extent of storage-room thus afforded by this formation; both are necessary for the capability of yielding large quantities of water, for a thin stratum, however widely spread out, could never yield very large supplies. Now the area occupied by the New Red Sandstone in the Counties above named is over 1,000 square miles, and with an average rainfall of 30 inches, we may assume that every four or five square miles will be capable of yielding one million of gallons daily.* Taking the latter figure, we have a

* This rate of yield has been determined pretty well by several observations in Lancashire and Cheshire.

total supply of 200 millions of gallons capable of supplying at the rate of 20 gallons per head ten millions of people, or half the population of England and Wales. Such a calculation may doubtless be considered rough, and may require considerable modification on various accounts; but it will serve to show, after making every deduction, that we have, placed within reach, sources of supply which, if not inexhaustible, will certainly prove sufficient for the wants of many generations; for it is probable that at present not more than fifty millions of gallons are raised from the New Red Sandstone.

Some idea of the enormous supply which this formation is capable of yielding from wells advantageously situated, may be gathered from returns of some of the wells now in operation. Amongst the more remarkable is the Green Lane Well, which is situated about two miles east of Liverpool. The details of the works which have been carried on, as kindly furnished to the author by Mr. Duncan, will not be without interest, as they illustrate the connection which exists between increase of supply and increase of depth and diameter of the well, or boring, as the case may be.

The well was sunk in 1845-6, the surface being 144 feet above the sea-level, and the depth of the well 185 feet; or 41 below the sea-level.

At first the yield was 1,250,000 gallons per day. A bore-hole, 6 inches in diameter, was then driven to a depth of 60 feet from the bottom of the well, when the yield increased to 2,317,000 gallons. In June, 1853, the supply had slightly fallen off, being 2,303,000 gallons, upon which the boring was still further carried down 38½ feet, when the yield increased to 2,689,000 gallons. In June, 1856, the bore-hole was widened, and carried down 101½ feet farther, when the yield amounted to its present supply of 3,321,000 gallons per day. Now, in these boring operations, we arrive at the following results. In the first boring of 60 feet, the increase was at the rate of 17,783 gallons per foot; in the second, of 38½, the increase was only at the rate of 9,789 gallons per foot; and in the third only 6,277 gallons per foot. It is easy to perceive that any further increase would be at a rapidly diminishing ratio with the depth, until a zero point had been attained.

In 1850, the average supply from seven public wells in Liverpool was 4,216,784 gallons every twenty-four hours.* It is now probably upwards of 5,000,000 gallons drawn from an area of about twenty square miles. The wells of Manchester and Salford, of which only that at Gorton is public property, yield about 6,000,000 gallons, exclusive of the well at the works of Messrs. Bailey and Craven, at Agecroft, near Pendleton, where from a well and bore-hole reaching a total depth of 435 feet, it is stated that no less than 5,000,000 gallons a day can be raised when the engines are in full operation.†

* Mr. R. Stephenson's Report.

† The boring was executed with the machine of Messrs. Platt and Mather. For an account of the yield of this well I am indebted to Mr. S. C. Homersham, C.E., for whom the amount was ascertained in 1859.

Several wells have been successfully sunk near Birkenhead, one under the direction of Mr. J. Cunningham, for the Wirral Water Works Company, capable of yielding 2,000,000 gallons a day; others by Mr. F. Bateman, C.E., of which one at Flaybrick Hill, though still incomplete, yields 800,000 gallons.

At Nottingham, several wells for the supply of the town have recently been sunk under the direction of Mr. Hawksley, from which the supply is very large. The rock is there in the form of a slightly consolidated conglomerate, and hence extremely porous. One of the wells yields 3,000,000 gallons per day, another 2,880,000 gallons, and the supply from a third cannot be tested, owing to the fact that the inflow of the water is too great for the engines to make head against.

At Birmingham, out of 7,000,000 gallons supplied by the Company, 2,000,000 are derived from wells which will be very largely augmented on the completion of the works now contemplated, and which include the sinking of four new wells. There are also several large private wells in operation. These instances will probably be considered sufficient as regards wells; my last illustration will be that of a natural spring rising from the same formation.

The town of Leek, in Staffordshire, stands on a tongue of New Red conglomerate, lying in a valley bounded by hills of millstone grit. A short distance to the south of the town, the Wall Grange springs burst forth at the foot of a knowl of New Red Sandstone, from which all the Pottery towns, except Longton, Fenton, and Stoke, are supplied. The position of the well is shown in Fig. 1.

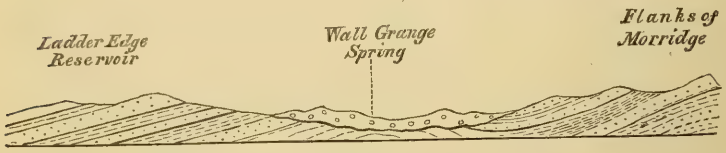


FIG. 1.—Section across Wall Grange Spring, near Leek.

These springs are estimated by Mr. Elliot, the engineer, to yield 3,000,000 gallons daily. The water is pumped up 287 feet by powerful engines into Ladderedge Reservoir, and hence distributed to the towns. The springs are uninfluenced by the seasons, and have supplied the towns since 1849. By two analyses made at different times, it has been found that the water contains from 8·70 to 12·26 grains of foreign matter per gallon.*

The porosity of the New Red Sandstone—owing to which water is able to percolate from long distances, is illustrated by the preceding examples. As only a small proportion of the rain which falls on its surface, varying from one-third to one-fourth, finds its way into the rock, it is evident that in order for a single well or spring to yield 3,000,000 of gallons a day, the supply must be drawn from con-

* 'Geology of Leek.' By T. Wardle, F.G.S.

siderable areas around. The porous character of the rock also finds another curious illustration in the case of some of the Liverpool wells. Out of four large wells in the lower part of the town, three have become charged with brine from the sea, owing to the extraction of the fresh water, and the general lowering of the water-level in the rock. The most remarkable case is that of Mr. M'Gregor's Well, situated at a distance of 1,200 yards from the shore, which now yields salt water. The cause of this is not difficult of discovery. Before pumping operations were commenced at Liverpool, the water-level in the rock was the same as that of the sea close to the shore, but inland gradually rose with the surface of the ground. Thus, when the Green Lane Well was first sunk, the water-level was found to be only 38 feet from the surface, or 106 feet above the sea. The sinking of many wells, and the extraction of the water from the rock, necessarily tend to lower the water-level, and near the sea to bring it below the sea-level. The balance of the water in the rock, and that of the sea being thus destroyed, the sea-water forces a passage for itself inwards. The water-level at Green Lane is now 70 feet from the surface, that is, 32 feet lower than when the well was first sunk.

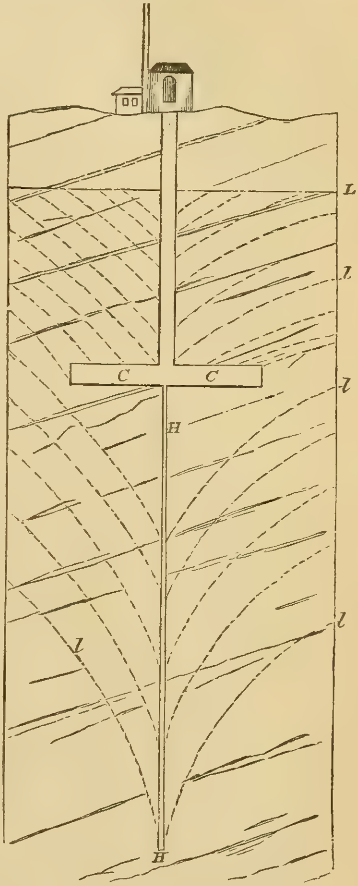


FIG. 2.—General Section of a Well, with Chambers and Bore-hole.

Notwithstanding the porous character of the rock, the process of percolation is extremely slow, and on this account the sinking of a well has little or no effect on the vegetation, and sometimes a shallow well is not perceptibly affected by the neighbourhood of a deep one. But a more remarkable result still remains. It has been found that the yield is greater in the summer—that is, in the six dry months—than in winter—the six wet ones. Mr. Hawksley, whose experience in these matters is undoubtedly large, stated in evidence before a Parliamentary Committee during the present Session, that of the total quantity of water drawn from deep wells in certain situations, 2-5ths are supplied during the six winter months, while 3-5ths are supplied

during the remaining six months of the year, so that six months is required for percolation. The same fact has been stated to the writer in the case of a well in South Lancashire, and it is owing to this remarkable property of admitting of slow percolation that the rock becomes in effect both a natural filter and a reservoir. During the slow percolation of the surface-water—noxious impurities are separated from the pure element, and a store is also laid up in seasons of plenty to be dealt out in times of dearth. On the other hand, water derived from surface drainage, in order to be made permanently useful, requires the construction of "lodges" or basins for the storage of the surplus waters of wet seasons.

It may here be proper to describe shortly the process of filtration as well as the general manner of constructing a deep well in this New Red Sandstone. (See Fig. 2.)

The site having been chosen, a well of a diameter sufficient for the play of a double-pumping engine, is commenced and carried down till the natural water-level (*L*) is reached. A temporary (or permanent) engine is then put up, and the water is kept down, until it threatens to become too plenteous for the engines to deal with. Large chambers or tunnels (*C C*) are then generally driven in opposite directions for lodgment, and from the floor, a bore-hole (*H*), of 6 to 12 inches in diameter, is driven to any required depth. Now the manner in which the water is drawn from the surrounding sandstone rock is somewhat as follows. Before the well is sunk, and supposing the rock to be homogeneous (which is, of course, not strictly the case), the water will be found standing at a certain level depending on the position of the springs and other natural or artificial sluices. This water-level (*L*) is only approximately horizontal, as it tends to vary with the surface, and rises and falls according to the season. The water, however, is at rest, or *in equilibrio.* But when a well is sunk below this level, and this water is extracted, the equilibrium is disturbed. A vacuum is created into which the surrounding waters will flow, in order to fill it up. Two forces will then be brought into play—gravity and lateral pressure acting vertically and horizontally—both of which are resisted by the friction of the rock—which will be proportional to its density—and the resulting motion will be a diagonal series of curved lines (*l, l, l,*) converging towards the axis of the well. From the above description it will be apparent that in order to increase the area of supply, it is necessary to deepen the well—and that the limit to the distance will be reached when the friction of the rock is equal to the lateral pressure.

The above general principles are subject to modification, arising from the unequal density of different beds, the stratification of the rock itself, bands of marl faults and fissures. As the effect of these latter is not unfrequently a matter of controversy, I shall say a few words on the subject here.

Faults (or vertical dislocations) in the New Red Sandstone differ from those in the Coal-measures in being filled in with broken silicious material (often indeed ground and hardened, but full of fractures), instead of clay or other impervious matter, which in the working of a coal mine often renders the presence of one of these faults a bar-

rier to the passage of water, and a very great blessing to the miners. Faults in the New Red Sandstone, hundreds of which the writer has examined over the Central Counties, cannot therefore be regarded as impervious to water, because the material with which they are filled in is not itself impervious. It is not improbable, however, that they tend to retard the flow of the water in a transverse direction; but on the other hand, they act as channels, and ducts, to guide it longitudinally. Hence the writer would (*ceteris paribus*) always recommend the line of a fault as the best site for a well, as it is certain to draw from a long distance. The effect of a fault in suddenly increasing the supply when driven into underground was illustrated in the case of the well at Flaybrick Hill, near Birkenhead. Mr. Bateman, the engineer, recently stated* that in driving a tunnel from the bottom of the well, they struck upon a fault of several feet in width, when the supply, which had only been 400,000 gallons per day, was suddenly doubled. What will be the effect of cutting through one or more of such faults in tunnelling under the bed of the Mersey, is a matter which is exciting much controversy between the promoters and opponents of the Railway Tunnel scheme; but that the former contemplate in any case a very large influx of water from the bed of the river may be concluded from the fact that they are preparing pumping powers for twelve millions of gallons per day. The project, however, is now in abeyance.

Quality of the Water.—We now come to the last and not least important question, the quality of the water from the New Red Sandstone, as ascertained by experience. It is but fair to say that on this point much variety of opinion exists, as there are different views as to what constitutes "hard" and "soft" water, and as the water itself is somewhat variable. That it is pleasant, and sparkling, and good for drinking, none will be disposed to deny; and, as regards hardness, it is certainly not as soft as the water from Lough Katrine, while it is softer than that generally drawn from wells in the Chalk formation.

In Manchester, Stockport, and other places in the North of England, the waters from wells in the New Red Sandstone and Permian formations are extensively employed in brewing, bleaching, and dyeing; and though salts of iron, lime, and magnesia exist in almost all cases, we are only aware of one solitary instance where the water proved unfit for use by the excess of any of these salts.† The case alluded to occurred at Ordsall, near Manchester, and is, we think, the result of exceptional causes capable of explanation. On the other hand, a well in the same formation at Parkside, on the London and North-Western Railway, produces water of such purity, that Mr. Ramsbottom declared to the writer that it was the purest water for the supply of locomotive engines on the whole of the railway system.

The terms "hard" and "soft" are often used in a sense that is vague and unsatisfactory, but adopting the views of Dr. Clark, that it is the presence or absence of salts of lime and magnesia that constitutes

* Before the Parliamentary Referees on the Mersey Tunnel Bill, 1865.

† It need hardly be mentioned that our remarks exclude all notice of the water derived from the *New Red Marl*, the upper division of the Trias from which the principal supply of salt and brine is derived.

hardness or softness, while those of potash or soda are neutral, we have an intelligible basis of comparison. According to this view, which is very generally adopted, we may express the degree of hardness in a sample of water according to the number of grains of salts of lime and magnesia per gallon it contains. The standard of purity is water obtained by repeated distillation, but for ordinary purposes absolutely pure water is unfit for use, the presence of mineral matter being essential to the animal economy. Water which contains mineral matter in small quantities is the best adapted for use, and such, we think, it can be shown is the character of that derived from wells in the New Red Sandstone.

We proceed to give the results of analyses of samples derived from wells in different parts of the country, commencing with Liverpool, which will serve to give reliable information regarding the quality of the water. Several of these analyses have been kindly supplied for this paper.

Analyses of Water from Wells in New Red Sandstone.

LIVERPOOL DISTRICT.

The following analyses were made by Mr. Richard Phillips, for the Liverpool Corporation :—

	BOOTLE. Grs. per gal.	SOHO. Grs. per gal.	WINDSOR. Grs. per gal.	GREEN LANE. Grs. per gal.
Sulphate of Lime .	3·31	5·44	0·49	0 00
Carbonate of Lime	7·10	2·94	8·70	5·26
Carbonate of Magnesia	6·93	8·81	7·43	2·66
Chloride of Sodium	3·37	4·47	3·42	2·23
Silica .	0·48	1·12	1·20	0·63
Organic matter, Potassium and loss	2·81	2·02	1·94	2·81
	24·00	24·80	23·22	13·60

MANCHESTER DISTRICT.

As a general result the waters from the Manchester wells contain 14 grains of salts of lime in a gallon, *viz.* 8 grains of sulphate and 6 grains of carbonate. For the following special example, taken from the south side of Manchester, the author is indebted to Dr. R. Angus Smith, F.R.S. :—

	Grs. per gal.
Chloride of Sodium	4·88
Sulphate of Soda	7·33
Carbonate of Soda	7·35
Carbonate of Lime	9·77
Carbonate of Magnesia	5·29
Phosphoric Acid, Lithia, Potash	traces
	34·62

Degrees of hardness . . 15·0

The Lithia was seen by the Spectroscope.

Analysis of Water from a Well at Parkside, near Warrington, belong-

ing to the London and North-Western Railway, by Mr. Dougall Campbell, F.C.S., of London. Total solid contents per gallon 11·12 grains, consisting of:—

	Grs. per gal.
Silica	0·80
Oxide of Iron	0·24
Carbonate of Lime	1·07
Sulphate of Lime	1·63
Sulphate of Magnesia	1·46
Carbonate of Magnesia	0·70
Chloride of Magnesium	0·71
Chloride of Sodium	1·76
Volatilized Matter	2·64
Potassium and loss	0·11
	11·12

Degree of hardness before boiling .	5·8
„ „ after boiling . .	4·1

Analysis of water from a well belonging to the Waterworks Company at Aston, near Birmingham, by Dr. Hill, F.C.S., Analyst to the Borough of Birmingham:—

	Grs. per gal.
Carbonate of Lime	4·40
Carbonate of Magnesia	2·70
Carbonate of Soda	1·62
Chloride of Sodium	1·08
Sulphate of Soda	0·70
Silica, Iron, Alumina	0·62
Organic matter	1·70
	12·82

Degree of hardness before boiling .	5·9
„ „ after boiling . .	1·5

Dr. Hill has assured the writer that the above may be considered an average sample of the water around Birmingham, as it is similar to a specimen from the well of the borough prison, which lies at an opposite quarter of the town.

Wall Grange Spring, near Leek, Staffordshire. Analysis by Mr. Phillips, in 1847:—

	Grs per gal.
Chloride of Sodium (common salt) . .	1·33
Sulphate of Lime	5·79
Carbonate of Lime	4·73
Traces of Magnesia, Silica, Organic Matter, and loss by operating	0·41
	12·26

Degree of hardness . . .	10·5

The following analysis of the water from the well of the Stourbridge Water Company has been kindly supplied by the resident engineer, Mr. E. Bindon Marten. The well is only 46 feet deep, and yields about 200,000 gallons per day.

WELL AT STOURBRIDGE, WORCESTERSHIRE.

	Grs. per gal.
Carbonate of Lime	15·23
Sulphate of Lime	0.47
Sulphate of Magnesia	1.67
Chloride of Sodium and Alkalies	1·76
Organic matter	2·07
Loss	0·77
	21·95
Degree of hardness	17·2

We regret that we cannot furnish a special example from the wells at Nottingham. We are only able to state that the analysis of one of the principal wells gives of salts of lime and magnesia 11·8 grains, other salts 4·2 grains, and of volatile and combustible matter 0·88 grains; making in all about 16·80 grains per gallon. The foregoing examples will, however, probably be considered sufficient to establish the character of the water from the New Red Sandstone.

In order, however, fully to understand the position which the water from that source holds in the scale of purity, we must compare it with that at present supplied to various towns from other sources. From the above cases it will be observed that the quantity of ingredients varies from 6 to 34 grains per gallon. Let us see how this bears comparison with other waters.

Amongst the towns which are supplied with the purest water are Glasgow, Manchester, and Aberdeen, from Lough Katrine, the Yorkshire Hills, and the River Dee respectively. In these cases the water is supplied by the surface drainage of hilly districts formed of ancient Palæozoic formations, and the ingredients vary from 2·95 to 4·00 grains per gallon. Such waters are undoubtedly purer than any that can be drawn from wells, but they are more liable to be charged with peaty matter, especially after rains.

Amongst those in the next scale may be placed Newcastle and Paris, supplied from the Tyne and the Seine respectively, which contain from 11 to 12 grains per gallon.

Amongst those in the third class, the various districts of the Metropolis may be placed, and these labour under the serious disadvantage of being charged with organic impurities in proportions varying from 1·40 to 3·68 grains per gallon. The purest of these waters seems to be that of the New River Company, which contains 17·20 grains, and the least pure that of the Kent Company, which contains no less than 29·84 grains of ingredients to the gallon, of which 3·68 grains are organic matter.

Having regard then to the instances here cited, we think we can have no difficulty in assigning to the waters from the New Red Sandstone an intermediate position, with this great advantage, that nearly all the foreign ingredients must be mineral and not organic.* In truth,

* The sample given above, from Manchester, containing 34 grains of various salts, is evidently somewhat exceptional, and may possibly be affected by buildings and factories.

the rock is a wonderful natural filter. Receiving as it does on its surface water from various sources, and charged with impurities of various kinds, it imbibes a portion, allows it to percolate downwards in a slow and gradual descent, every instant extracting some noxious particle, till the liquid is freed from every substance injurious to human life, and is returned to us limpid as the waters of a brook which gurgles along the rugged bed of a Highland glen.

THE DEPREDATIONS OF INSECTS AND THE PROTECTIVE VALUE OF SMALL BIRDS.

By PROF. JAMES BUCKMAN, F.L.S., F.G.S., &c.

THE readers of this Journal are well aware that a doltish antipathy to small birds has for a long time prompted a crusade against those useful little creatures, and with a view to expose the senseless nature of these proceedings as well as to give to the uninitiated reader some insight into the character of the plague which is thereby enabled to spread unopposed, I propose in the following brief observations, to treat of one particular insect enemy, whose devastations have recently forced themselves in an unpleasant manner upon my notice; I mean that commonly known as the Striped Pea Weevil.

Both in my garden and in the field I have of late lost crops of peas, and in some cases the loss has been rendered more mortifying, inasmuch as I had selected choice seeds and devoted great care to the cultivation of early plants. In the case of the garden crop, my gardener had unhesitatingly attributed the destruction to "sparrers," whilst the cause assigned for the ruined appearance of the plant in the field was "slugs." The real cause was, however, the little insect which I am about to describe, and which, on the occasion to be referred to, I found flying about in such numbers, that they became entangled in my whiskers, and thus gave unmistakable evidence of the wholesale destruction which they must inevitably cause.


FIG. 1.—Entire Leaflets of an uninjured Pea-plant.

If we look at the leaf of the young pea we shall find it to consist of two *entire* leaflets, that is, without divisions at the margin—"*leaf bifoliate, leaflets entire;*" and which is terminated by a tendril which represents other leaflets diverted to the purposes of climbing.

Now in the injured leaves we have the appearance of pieces having been bitten out around the margin: this is either unobserved, or if noticed, it is thought by some to be the nature of the leaf, while of those

who recognize it as abnormal not a few, as it seems, put it down to the pecking of birds, or the bites of slugs. The following woodcut will explain the nature of the injuries we are describing.

FIG. 2.—Pea Leaves eaten by the Pea-weevil.

Our Fig. 2 represents a much eaten leaf, but in some the parts are so evenly eroded as to cause them at first sight to appear to be the natural toothing of the leaf. A little reflection will, however, show us that we have no examples of leaves so *escalloped* (not to be confounded with *crenations*, which consist of a series of outward and not inward marginal curves). In some instances the whole leaf is destroyed, until indeed the plant ceases to live, as it has been the case with my garden crops; and this year my field crop has suffered a loss of about one half. I counted as many as 25 insects to a foot of the row, or 1650 to every chain in length, and Curtis asserts that "in the year 1844, they were universally distributed and ate off the *second and third sowing;*" and he further adds, that "some very naturally accused the sparrows; traps were set for rats and mice; lime strewed for slugs and snails; and toads were encouraged to extirpate wood-lice; but still the crops kept disappearing, as none of these precautions affected the wary enemy in his coat of mail."

It is now time to describe the nature of so mischievous a creature, which belongs to the order *Coleoptera*, family Curculionidæ, genus Sitonia (Curculio). Of this there are two species which attack our peas, beans, clovers, and other Papilionaceæ, *namely :—*

Sitonia lineata (Linn.), the Striped Pea Weevil.

Sitonia crinita (Olivier), the Spotted Pea Weevil.

These vary in size from two to three lines, the latter being somewhat less than the former; they are both brownish externally, much of the colour of the soil. The S. crinita appears darker and sometimes almost black when the greyish scales are worn off the Elytra,—otherwise they are much alike, and behave so similarly, that a description of S. lineata may serve for both.

It is of an earthy colour; is more or less elongated into an elliptical or oval shape. They may be seen sometimes in threes and fours on the edges of the leaves making the notches, as shown in the woodcut, and when these are present in the crop, the creatures will soon be detected in the act of feeding, if cautiously approached; if not, they fall off and disappear beneath the clods of earth, where they feign death, until all sign of danger has passed away.

Where the creatures are bred is at present a mystery, but I suspect that this operation takes place on wild Papilionaceæ, from which they migrate to their more pleasant food of peas, and it would appear that the more delicate of these are the favoured food of this mischievous creature.

In my own crop, not having enough of the early Warwick—a fine white pea—the headland was drilled with a grey pea, the nine pod;

the former were nearly destroyed, while the latter as nearly escaped altogether. So in an adjoining field belonging to a neighbour, there is now a fine crop of grey peas almost untouched. Curtis, in his 'Farm Insects,' says, "From the imperfect and slender data relating to insects connected with agriculture, it is frequently difficult, if not impossible, to form any opinion as to the simultaneous or periodical appearance of the different species; and with regard to these Weevils, all that can be stated is, that certain seasons seem to favour their multiplication, and others to check it. It is evident that if not checked, there is not a crop, whether in the field or garden, that would escape destruction; and this check, probably in every instance, might be traced to the agency of other insects, especially parasitic species, which I have so often shown are destined to the service of man."*

But now the question arises whether the parasites referred to by Curtis have not some good assistants in this goodly work of destroying noxious insects.

Now it happens that about my farm there are, amongst other birds, hundreds of larks, *Alauda vulgaris*, and white water wagtails, *Motacilla alba.* My pupil, A. Taylor, Esq., has occasionally shot specimens of these and other species, and has examined them in order to determine their food; in the crop of a lark from this very field were several of these weevils, and in the gizzard a complete débris of small insects. In the wagtail, from the same field, the crop was full of weevils, and in the gizzard, a mass of elytra of these and other small beetles.

A reed-warbler (*Silvia arundinacea*) again from the farm, had in the gizzard twenty-five beetles of different species.

This then seems to be the tendency for good of some small birds; so much so indeed that if they were allowed fair play, I believe that this periodical superabundance of insects from which our crops frequently suffer would be rendered next to impossible.

As a curious illustration of what even seed-eating birds do, I may direct attention to a hedge sparrow, *Fringilla montana*, shot in the pea-field. In its gizzard were found several hundreds of the seeds of the *Chenopodium album*, a weed which was very troublesome in a potato crop of the former season. All sparrows then are not mischievous, nor indeed any, at all times.

It seems then from the foregoing that crops are liable to a variety of insect attacks; as these injuries were supposed to result from birds, the birds have been destroyed as enemies, while a knowledge of the real truth should lead us to preserve them as friends.

In the case before us, were it not that a very much-used path skirted the pea crop, the injury I have described would, in all probability, have been kept under by the birds, a fact which in this and in other instances has led me to attempt plans to prevent their molestation, rather than to adopt that everlasting opposition to them which has been productive of so much mischief.

* P. 347.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

In the current number of the 'Transactions of the Highland and Agricultural Society,' Professor Thomas Anderson has described his experiments on the action of uric acid as a manure. They are of considerable importance as illustrating the fertilizing action of guano. Of this, indeed, agriculturists need no other proof than that which their own experience offers; but for harmonizing this experience with the theory of manures, any attempt must do valuable service which shall ascertain the influence upon the growth of plants exercised by those other nitrogenous ingredients of guano, which are present in addition to its ammonia. It is because Liebig had declared that in discussing the value of Peruvian guano as a manure the nitrogen present in its uric acid should not be taken into account, that Dr. Anderson has made it the subject of his present research.

Peruvian guano, guano ash, uric acid, and sulphate of ammonia, were the materials employed in his experiments. The first formed the standard, and it was contrasted first with a mixture of its own ash with uric acid in such proportion as to contain exactly the same quantity of nitrogen as the guano itself did, and next with a similar mixture of the ash with sulphate of ammonia. The crops (turnips and wheat) thus received in every case exactly the same quantities of mineral matters and of nitrogen, but the latter element existed in one case entirely as uric acid, in another entirely as sulphate of ammonia, and in the guano itself partly as ammonia and partly as uric acid. The results on the turnip crop were obtained from a late sown crop, and are so far not altogether satisfactory; they proved in every case the mixture of guano, ash, and sulphate of ammonia to be best; then the guano itself; and lastly, the guano ash, and uric acid. The conclusion here, therefore, was favourable to the ready formed ammonia as a source of nitrogen. It is not, however, upon the turnip crop, but upon the grain crop, that the true effect and influence of nitrogenous manures is to be read. And on the wheat crop it appeared that the guano ash by itself was entirely without effect; the produce, where it alone was used, being no better than where nothing at all had been applied. In every case, however, the nitrogenous manure produced a very marked increase in the crop, and but little difference was observable in the action of the guano, the uric acid, and the sulphate of ammonia. In one set of experiments the guano was best, the sulphate of ammonia next, and the uric acid third. In another series, the uric acid was first, the sulphate of ammonia second, and the guano third. Taking the average of the two series, the produce per acre of equal quantities of nitrogen in the manure, in the form of uric acid, was 50·9 bushels per acre; in the form of guano, it was 49·8

bushels per acre; and in the form of ammonia, 50·4 bushels per acre. Where nothing had been used as manure, the produce was 40·9 bushels per acre; and where guano ash alone was used, the produce was 40·1 bushels per acre. As Dr. Anderson states, although these experiments will be the better for confirmation, yet in the meantime they establish beyond all doubt that uric acid is capable of promoting the growth of plants and that, as a source of nitrogen, it is on the whole equal to sulphate of ammonia or guano.

Mr. Lawes has subjected to an experimental test the suggestion of Professor Voelcker, that in order to increase the efficiency of Peruvian guano as a manure for root crop, it would be well to moisten it with sulphuric acid, this being best effected by mixing it with sawdust, over which the sulphuric acid had been poured. It was supposed that the guano would be increased in efficiency, both by its volatile ammonia being thus fixed, and by its phosphate of lime being rendered soluble. The experiment performed in a dry season, which produced a very poor crop of roots, did not corroborate the suggestion: the crop from 8 tons of dung and 200 lbs. of Peruvian guano in its natural state being rather better than where the guano added to the dung had been previously treated as was suggested. On the other hand, when to both of these dressings 2 cwt. of superphosphate of lime had been added, there was a corresponding small advantage the other way. The results on the whole, therefore, are nugatory; and as the cost of the acid and expense of mixing were thus spent for nothing, the experiment, so far as it goes, discourages the practice which had been recommended. Several sets of experiments have been lately published on the value of ground coprolites, as a manure for the turnip crop. Mr. Baldwin, of Glasnevin, Dublin, Mr. Kensington, F.C.S., and others, have observed a marked increase of produce from their use, which contradicts the general impression of their worthlessness in an undissolved state. The experiments need, however, repetition.

Dr. Voelcker has called the attention of the English Agricultural Society to a source of potash as a manure which has recently become available. A great thickness of potash, bearing earthen beds, is traversed in the Strassfurth Salt Mines, before the enormous deposit of pure rock salt is reached which there exists. Various extracted potash salts are obtained from these preliminary beds, some of them deliquescent muriates, and one, a sulphate, selling at about 3*l.* a ton, and containing 20 per cent., which is likely to be imported into this country for agricultural purposes. Dr. Voelcker recommends experiments with these crude potash salts upon light soils for turnips, potatoes, and clover: (1) alone, at the rate of 3 cwt. per acre; (2) alone, in comparison with an equal quantity of common salt; (3) mixed with an equal quantity of superphosphate of lime; and (4) mixed with 3 cwt. each of both common salt and superphosphate. The bean crop has been benefited in farm practice by the application of wood ashes as a manure, and these potash salts may thus also be applied to beans with some prospect of success.

Baron Liebig has published a letter upon the progress of the artificial manure manufacture in the Grand Duchy of Hesse, de-

claring that since Dr. Schneider commenced in that district, ten years ago, as the agent of the Rhenish Agricultural Society, to lecture on the principles of the so-called "Mineral theory," fifty-seven depôts of artificial manure have been established within an area of twenty-five geographical (German) square miles, or nearly 340,000 acres. During 1863, 90,000 tons of artificial manure, more than 5 cwt. per acre over the whole of this area, were used; and in consequence of this habitual use of imported fertilizers, rents have risen 20*s.* per acre, corresponding to an increased capital value of 10,000,000*l.* over the whole district, or 30*l.* per acre. This Liebig considers "a proof that the state of agriculture in land is really improving." And holding firmly to his previous declaration, that owing to our waste of sewage, the fertility of Great Britain is undergoing an exhaustion, he contrasts it with our average use of guano and other imported fertilizers which he puts at 400,000 tons per annum, or something less than 28 lbs. per acre. "This simple fact shows," he says, "how very small, comparatively, is the augmentation of the conditions of fertility in the English soil by the importation of manure. On the other hand, the loss of manure suffered by agriculture through the waste of the sewage is notorious, and may be found far exceeding the amount made good by importation; and then the inevitable conclusion remains, that as a whole the soil of England, instead of gaining, must actually decline in productive power." It is impossible to avoid the conclusion to which Liebig's previous writings lead, that there is a strong prejudice which warps his mind in the case of any comparison of Germany and England. His great proof of agricultural progress in Hesse is none other than that dependence on supplies of fertilizing matter from without, which has been more than once condemned by him, when alleged by Englishmen as some explanation or palliation of their folly in the neglect of their home supplies with which his letters on the sewage question charge them.

A little book on 'High Farming without Manure,'* has lately been published, being an English translation of six lectures on Agriculture delivered by M. George Ville, at the experimental farm at Vincennes. But the title, which would indicate a much easier solution of our agricultural difficulties than either Liebig or his Hessian model farmers could afford us, is not a correct designation of its contents. M. Ville first recommends a thorough fertilization of the soil, and thereafter the application, before every crop, of the special fertilizer which he supposes it to need. This is *nitrogen* for cereals, *potash* for beans and pease, and *phosphates* for roots. This, however, is no new doctrine here. The English farmer has all along tried to keep his land in good heart by an economical use of home resources, and to these he adds guanos and nitrates for his grain-crops, and bone-dust and phosphates for his root-crops. And so far from M. Ville teaching "High farming without manure," his lectures are specially directed to the maintenance of the general fertility of the soil by the application of a compound and complete fertilizer; and

* W. Olliver, 3, Amen Corner, Paternoster Row.

afterwards to the maintenance of its fertility as regards every separate crop by the application of the special or dominant ingredient of the complete manure in which that crop makes the largest and most severe demands. It is not, however, so much by this latter particular treatment, as by the former general treatment that English farmers aim at the maintenance of fertility. It is an agricultural, not a purely chemical question, of which their practice is the true exponent. And the principal and leading explanation of an increasing fertility whenever over any considerable district in the country it is witnessed, exists in the maintenance of an increased head of stock upon a given area. Fortunately for English farming and for English soils, the relative state of the meat and corn market has of late more especially urged this as his interest upon the English farmer; and the purchase of sheep and cattle foods—both cakes, the refuse of the oil manufacture from various oil-bearing seeds, and grain and meals of various kinds, which have been unusually cheap—has become the best security for farm profits, whether they are dependent upon the quantity of meat made upon and sold from the farm, or on the quantity of corn grown there, owing to the increased quantity and quality of the manure thus made.

The value of covered yards for stock has been the subject of discussion during the past quarter before the London Farmers' Club and in the pages of the 'Agricultural Society's Journal.' Shelter for feeding cattle is useful, both as economizing the use of food in the processes of nutrition, and as preserving the soluble and fertilizing ingredients in the manure made during the feeding process. To this, ample testimony exists in agricultural experience, and has been lately borne by our leading agricultural authorities. The related subject of cattle food has also been of late discussed: Mr. Lawes' experiments on the nutriment in raw and malted barley respectively, have established the fact which might have been anticipated, on theoretical grounds, that the process of malting, by its destruction and dissipation of much of the actual material of the grain malted, diminishes the feeding powers of a given quantity of barley. The general result of Mr. Lawes' inquiry is, that in only one of the comparative experiments, *viz.* in the first and second lots of sheep experimented on, which were fed respectively, besides other things, on barley and on the malt produced from an equal quantity of that barley, was the increase of the weight higher, and the amount of food required to yield a given amount of increase lower, from the malt than from the barley; and in that instance the amounts were very nearly the same in the two cases. In all the other comparative trials, whether with oxen, sheep, or pigs, the advantage was with the barley, and in a greater degree than it had been with the malt in the single instance quoted.

An excellent and elaborate account of the existin gcattle foods, both home-grown and imported, was given by Professor J. Coleman, in a lecture before the Society of Arts, on April 5. Among other new substances named was the palm-nut kernel meal, which contains no less than 25 per cent. of a feeding oil, and 15 per cent. of flesh-forming material, and has proved on trial with cattle, sheep, and pigs,

one of the most efficient and cheapest purchased foods we have. Its effect on dairy cattle in the production of milk is especially noteworthy.

Among the other topics which have been brought under the notice of agriculturists during the past few months by our agricultural societies are Flax-culture, Grass-land Management, Irrigation and the Water Supply, and Agricultural Education.

Flax-culture has received a large extension of late years both in this country and in Ireland, owing to the increased value of the fibre, which has been due to the diminished cotton supply. Mr. Beale Browne made it the subject of a recent lecture before the English Agricultural Society, in which he declared that it had lately proved more profitable than the wheat-crop, which it followed, even upon the poor thin Cotswold soils, where he had grown it. And in Ireland, where two successive crops may be had of the crop on freshly broken-up moory soil, which will grow nothing else until it has been limed, it is still more profitable. A rettery for extracting the fibre, where a market may be obtained for flax-straw, must be established, before flax-culture can be profitably introduced into any new locality; and there seems every reason to suppose that the crop may in this way, more generally than has hitherto been the case, obtain a place in the crop rotations of English farmers.

Grass-land management was discussed at some length at a meeting of the London Farmers' Club, being introduced by an exhaustive paper on the subject from Professor Coleman. Land-draining, and grazing with the use of auxiliary foods given both to cattle and sheep, are the great agents in the improvement of our pastures. The former has always been a profitable operation; and the latter is becoming more and more so with the rising price of meat in this country.

Irrigation, which is another great agency in the production of an increased grass-crop, was the subject of discussion by Professor Voelcker, before a recent meeting of the Agricultural Society of England. His lecture referred especially to the kinds of water suitable for use in this way. These were declared to be specially sewage water; next, those spring-waters which are of a uniform temperature throughout the year, both because they are thus warmer in the winter and spring months when an early growth of grass is thus promoted, and also because this uniformity of temperature indicates that such waters come from considerable depth; and having thus traversed a large extent of earth and rock, they are the more likely to have dissolved the various mineral matters met with, which are serviceable as the food of plants. Lastly, drainage waters are of service for irrigating the lower lands. And this is of importance, as checking that rapid flow of flood and rainwater from the field to the final outfall in the river, by which, as Mr. Baily Denton has often pointed out, the extension of land drainage is really affecting the water supply of the country; and, hurrying it straight away to the river, is tending more and more to make floods felt in all the low-lying lands. If by storage for irrigation purposes some use of such

waters can be made before their final outflow into the river, a great social, as well as a mere agricultural, benefit will have been conferred.

Our last topic is agricultural education. The opening of the so-called Albert Middle Class College, in the county of Suffolk, during the past quarter, may be named under this head, as contributing both a good example for other counties, and directly to the work of general, and therefore indirectly to that of agricultural, education. It has however, been effectively shown by Mr. J. C. Morton, in a paper read by him before the Agricultural Society of England, that the general education of the farming class has during the past generation very greatly advanced; whereas the condition of their professional education is not so satisfactory. The sons are not better farmers, though they are better educated men, than their fathers were. Agricultural progress has been owing to improved means and improved machinery, to imported manures and cattle-foods, to land-drainage and better machines for cultivation—not to increased skill or greater agricultural knowledge. The object of the lecture was to induce the society to exert itself in its own legitimate field for the promotion of professional agricultural education — not to throw its small contribution to the subject into the great sea of general middle-class education, where it will not be felt. The Agricultural Society has, however, in the meantime, resolved to persevere in the experiment to which it is committed; and some 200*l.* accordingly have been devoted for the year in prizes to the sons of farmers who shall pass the best examination, before the university local examiners, in certain branches of a general education.

It is to be hoped that hereafter the society may labour in its own proper field as a professional agricultural body, offering prizes for agricultural proficiency, for knowledge of those branches of science in which agriculture is especially interested, and for intelligence and skill in the various departments of farm management.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

One of the most interesting lectures delivered at the Royal Institution this season was devoted to a retrospect of the latest discoveries concerning the Sun's surface. The lecturer was Balfour Stewart, F.R.S., and although much of the matter brought forward has necessarily appeared from time to time in the pages of scientific journals, and especially in our own, we are tempted again to place it before our readers in a connected form, by giving a brief ab stract of this valuable discourse. The speaker commenced by drawing attention to the points of visual difference between our two luminaries —the sun and the moon. The surface of the latter has been almost as correctly mapped as that of our own globe, so that astronomers have long known what parts of her were mountains, and what valleys; for it was comparatively easy to argue respecting a set of phenomena

which do not differ greatly from those which belong to the surface of our earth. But the phenomena in our sun are so entirely different from any that we experience, and perhaps from any that we can conceive, that we must be exceedingly careful in our conclusions regarding them, that we may not be mistaken. We must throw away all speculation and hypothesis, and submit to be guided by observation alone. The luminous disc or surface of the sun is termed its photosphere, and inquiry with reference to this surface may be divided into three parts: the first, relating to the region above the photosphere; the second, to the photosphere itself; and the third, to the region below the photosphere.

To commence with the region above the photosphere, it is easy to show that it contains a very dense atmosphere which is of a comparatively low temperature. In the first place, according to a well-known law, the dark lines in the solar spectrum denote the presence of certain substances in the state of vapour, and yet in a comparatively cold state above the photosphere of the sun. These substances comprise, amongst others, sodium, magnesium, iron, and nickel.

Another proof of the existence of a solar atmosphere is that the light from the border is less intense than that from the centre of the disc; this is due to the fact that the light from the border has to pierce through a much greater depth of atmosphere than light from the centre, and hence a great portion of the light from the border will be absorbed by this atmosphere if it be colder than the source of light. The last proof of an atmosphere is that derived from the picture of the sun taken during a total eclipse. At the lecture some of Mr. De la Rue's celebrated eclipse photographs were projected on to the screen by means of the electric lantern, and the images of the corona and "red flames" were in this way exhibited to the audience. These photographs showed that as the moon proceeded over the sun's disc, the red flames and part of the corona discovered themselves at that side which she had left, and were covered up by her disc at that side towards which she was approaching; thus showing that they belonged to the sun.

Next, with regard to the photosphere, the first thing to be noticed is the fact that this is not a smooth, uniform, continuous surface. When it is viewed through powerful glasses, it appears granulated or mottled. But this is not all; there is reason to believe that great magnifying and defining power shows us something more, although it is very difficult to see it. Mr. James Nasmyth was the first to proclaim the curious fact that the whole photosphere of the sun is made up of detached bodies interlacing one another, and preserving a great amount of regularity both in form and size; he called them *willow leaves;* Mr. Stone has called them *rice grains*; Father Secchi *coups-de-pinceau.* It would be a speculation much beyond our power to conjecture what it is that gives these bodies their astonishing regularity of form. The lecturer then drew attention to the brighter portions of the photosphere, or faculæ, as they are sometimes called. It is chiefly near the edge of the sun that these relatively bright portions of the sun's disc appear, for when they come to the

centre the difference in brightness between them and the surrounding parts of the disc is not so easily traced. Now the reason of their great brightness is believed to be that they are portions of the sun's photosphere thrown up into the higher regions of the atmosphere. This enables them to escape a great portion of the absorbing effect of this atmosphere, which, as before shown, is particularly strong near the border, and hence when there they appear much brighter than the surface around them; but near the centre the absorption is not great, so that they do not *gain much* by escaping it. The idea that these faculæ are elevations, has been confirmed by a stereoscopic impression of a sun spot and some faculæ taken by Mr. De la Rue, and in which while the spot appears to be a hollow the faculæ appear as elevated ridges. It thus appears that the faculæ are elevated, and further, that they retain the same appearance often for a considerable time, sometimes even for days together, so that faculæ are not composed of heavy matter, otherwise they could not remain elevated; and hence the faculæ, as well as the photosphere of which they are only the most elevated parts, are not composed of heavy matter, such as a molten sea, but are rather of the nature of a cloud.

The phenomena of the third region, or that below the photosphere, may be comprehended in one word—sun spots. These consist of an umbra or central darkness, surrounded by a less dark penumbra. Mr. Dawes has discovered in some spots even a deeper darkness in the centre of the umbra. Now, if it be correct to suppose that spots are cavities, of which the umbra forms the bottom, and the penumbra the sloping sides, then the umbra ought to encroach on that side of the penumbra which is next to the visual centre of the disc. Professor Wilson, of Glasgow, was the first to remark that spots really behaved in this manner; and his remark has been abundantly confirmed by the Kew photographs taken under the superintendence of Mr. De la Rue. It, therefore, follows that the umbra of a spot is at a lower level than the penumbra; and since luminous ridges, and sometimes detached portions of luminous matter, cross over spots, it must be concluded that the whole phenomenon is below the surface. Again, spots exhibit the rotation of our luminary. If we turn to the south and view the sun, spots are always seen to pass from left to right. Besides the proper motion due to rotation of the sun, spots have also a proper motion of their own, first observed by Mr. Carrington; this motion is also from left to right; those near the solar equator moving fastest. Mr. Carrington also remarked that spots confine themselves to the equatorial regions of the sun. H. Schwabe, of Dessau, has remarked that spots have a period of maximum and minimum nearly every ten years, and General Sabine has found that the year of maximum sun spots is at the same time that of the greatest disturbance of the earth's magnetism.

A fitting supplement to the above lecture is to be found in the second series of Researches on Solar Physics: On the Behaviour of Sun Spots with regard to Increase and Diminution, which has recently been presented to the Royal Society by Warren De la Rue, F.R.S.,

Balfour Stewart, F.R.S., and B. Loewy, Esq. The object of this research has been to examine the question started by one of the authors of the paper, whether the behaviour of sun spots with respect to increase and diminution could be referred to some extraneous influence. In a table given, showing the behaviour of sun spots from the beginning of 1854 to the end of 1864, it is seen that different spots occurring about the same time on the sun's disc, behave themselves in the same manner; so that if one spot after making its appearance increases until the centre line, another will do the same; or if one spot breaks out on the left or on the right half, the other spots about the same period have a tendency to break out on the same half. The authors suppose that this peculiarity of behaviour of spots can only be explained by reference to some influence from without, and have attempted to answer the following questions:—Is this influence stationary? or if movable, can it be traced to any of the planets of our system?

In answer to the first question, it may be remarked that it cannot be found by investigation that there is any connection between a certain behaviour of sun spots and a certain period of the year, and hence there is no reason to suppose that the external influence is fixed. In the next place does this influence, if movable, move faster or slower than the earth? If faster it will pass over the sun's disc from left to right; but if, on the other hand, the influence move more slowly than the earth, it will move from right to left; so that a tendency of spots to form on the disc will be followed by a tendency to *increase*, not *decrease* after making their appearance. It is shown by a table that a tendency of spots to break out is followed by a tendency of spots to decrease after making their appearance, and it is thereby concluded that the influence moves faster than the earth. This would seem to point to either Mercury or Venus, as the agent in this matter, but the behaviour varies too slowly to be caused by the former. Venus therefore appears to be the influencing agent, and a table is given which seems to show that the behaviour of spots appears to be connected with the position of Venus in such a manner that spots dissolve when that part of the sun's surface in which they exist approaches the neighbourhood of this planet, while on the other hand as the sun's disc recedes from this planet spots begin to break out and reach their maximum on the opposite side. A legitimate deduction from these observations is, that the behaviour of spots is influenced by something from without; and from the nature of the spot-behaviour, the authors conclude that this influence travels faster than the earth; and finally, they find that the behaviour of spots appears to be determined by the position of Venus in such a manner that a spot wanes as it approaches this planet by rotation, and on the other hand breaks out and increases as it recedes from the neighbourhood of the planet, reaching its maximum on the opposite side. The authors do not, however, mean to convey the meaning that Venus is the cause of the ten-yearly period of sun spots, but merely that there is a *varying behaviour* of spots which appears to have reference to the position of this planet.

Proceedings of the Royal Astronomical Society.

The annual Report of the Council of this Society brought before the General Meeting in February last, arrived too late to admit of notice to be taken of it in our last Chronicles. In the mean time much that it contains has ceased to have any particular interest in these pages, and many of its announcements have already appeared in our Chronicles. We shall, however, briefly glance through the report (which occupies 70 pages of the Monthly Notices), and note anything which may appear worthy of record here. From the Proceedings of the various Astronomical Observatories, we extract a few matters of interest. At Greenwich no important changes, instrumental or otherwise, have been introduced during the past year. The connection between the Observatories of Greenwich and Paris, by which the Greenwich Observatory is charged with the Meridional Observations of the Asteroids from new moon to full moon, and the Paris Observatory from full moon to new moon, has been found to afford relief without any loss of valuable observation. During the autumn of last year, Colonel Forsch, Capt. Zylinski, and Doctor Tiele, gentlemen connected with the measurement of the Great Arc of the parallel between Orsk on the Oural, and Valentia on the West Coast of Ireland, were engaged in England in determining the differences of longitude between Greenwich and Bonn, Nieuport, and Haverfordwest.

At the Radcliffe Observatory the Heliometer has been chiefly used for the completion of the re-observation of Struve's *Lucidæ*, of which very few are found to exhibit any conspicuous orbital motion. The meteorological observations have been made and discussed with the same rigour as in preceding years, and the photographic sheets are found very useful in the comparison of storms passing over Oxford and other places, where there are found similar self-recording instruments.

At Cambridge, in addition to the usual work of an observatory, a very complete series of observations has been made for the purpose of determining by means of the method introduced by Professor Challis, the errors arising from the form of the pivots of the transit instrument. With the Northumberland Equatorial, observations have been made of Comet I., 1864, and also of the places of 747 Ecliptic stars. These have been made by means of a new eye-piece, of Steinheil's construction, made by Mr. Cooke, of York, and provided with a square bar micrometer, on a plan devised by Mr. Graham, the first-assistant.

The extensive works now in progress in the immediate neighbourhood of the Liverpool Observatory, have somewhat interfered with the general routine duties of the establishment during the past twelve months. Owing to the land on which it stands being required for dock accommodation, and the impossibility of finding any site on the Dock quays or near the margin of the river, which might not be wanted for dock extension in a few years' time, it has been decided to take the observatory over to the west-side of the river, where the Dock Board possess two acres of land on Bidston Hill, on which there are

at present a lighthouse and a telegraph station. These it has been decided to rebuild, and the observatory is also to be erected on this site, where it will be about three miles west of the present building, and about two hundred feet above the level of the sea. The site is favourable for astronomical and meteorological observations; it has the great advantage of security against being built around, or of being required for other purposes, and it is but little over a mile from the upper portion of the Birkenhead Docks. The plans of the new building have been decided on, and Mr. Hartnup hopes to be established in the new observatory by the latter part of the present summer.

From Edinburgh, owing to the absence of the Astronomer Royal for Scotland, upon a scientific expedition to Egypt, no report of this observatory is given.

At the Glasgow Observatory, the astronomical observations have been of the usual routine character. There are at present ten public clocks in the city of Glasgow, controlled by a current of electricity from the normal mean-time clock of the observatory, at an average distance of three miles from the controlling source. The Clyde Trustees have also decided upon establishing controlled clocks upon both sides of the river in behalf of the shipping interest, and steps are now being taken for laying down a new electric wire in furtherance of that object.

At the Kew Observatory, besides the valuable observational and instrumental work which renders this establishment so valuable to the man of science, photographs and observations have been taken of the sun's disc, at least two pictures having been taken on every day when this was possible. The results of these labours have been communicated to the Royal Society, and find appropriate record in our astronomical chronicles.

The researches in physical astronomy which have been carried on at Mr. De la Rue's observatory, and at that of Mr. Huggins, do not require notice here, as they are treated of at length elsewhere. The latter portion of the report is devoted to a review of the progress of astronomy during the past year. In it, however, we do not notice anything of importance which has not been recorded in these pages.

At the conclusion of the report, and in the form of a supplement, is given a summary of the important results of Mr. Lassell's observations at Malta, in the form of a letter. It will be sufficient here to indicate that in addition to the discovery of many nebulæ heretofore unobserved, and the careful re-delineation of others observed in England under less favourable atmospheric circumstances, and with telescopes of far less optical power, Mr. Lassell, after the most careful scrutiny, comes to the conclusion that the number of the known satellites of Uranus must be reduced from eight to *four*, and those of Neptune from two to *one*.

At the March meeting of the Society an important letter was read from the Rev. Father Secchi to Mr. Warren De la Rue. The author had been observing with a new prism for the solar eye-piece, forwarded to him by Mr. De la Rue. It consists of a Herschelian prism,

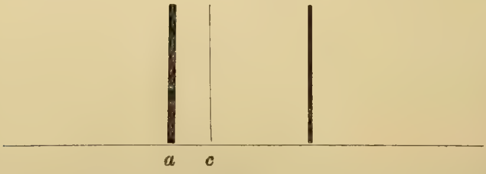
in which the reflecting surface makes an angle of 45° both in the incident ray and the axis of the eye-piece, and the second surface is at right angles with the transmitted pencil. With it observations may be made with comfort and ease, even for a very long time, without any fatigue to the eye, although with the full aperture. An examination of one very large spot gave Father Secchi a very good sight of the so-called *willow-leaves.* He observes that there is not in any place any uniform tint, but an agglomeration of oblong and white bodies, having one-third or one-fourth of a second of arc in breadth, and of very different lengths. It is very difficult to compare them to any terrestrial object, but the name of leaves is not very badly chosen. The accompanying woodcut, which has been copied by the kind per-

mission of Mr. De la Rue, gives some idea of the appearance of this spot, although the writer thinks that it is quite impossible to delineate it as it really appeared. What is very singular is, that these white bodies in some places agglomerate together so thickly that they constitute a continuing stream, but in general they are broken. These bodies are more apparent and separated when the spot is very enlarged, as it is in the present case. The general body of the sun is also made up of these oblong bodies, but of every form and dimension. A great many black pores seem to show that the photosphere is not a continuous stratum, but at the first sight it appears made of little

lumps, like so many little cumuli of cotton wool. On contemplating this kind of phenomena, the Rev. author says that he cannot divest himself of the opinion that the photosphere is really made up of clouds, and that the luminous stratum is actually constituted like our clouds, the only difference being that the clouds on the earth are of watery drops or crystals, and in the sun they are of some other substance in a state of suspension in the transparent atmosphere of the sun, like water in our own atmosphere. This opinion is enforced on observing the dissolving part of a spot, which presents all the phenomena of our cloudy sky; there are the forms of *cumuli*, of *cirri*, of *strati*, so perfectly equivalent to those of our earth, that sometimes the aspect of our clouds and of the hind part of the spot in the field of the telescope is exactly the same. What is very singular are the small bits of luminous photosphere in the middle of the nuclei, of which there is an example in the figure. The edge of the spot seems perfectly comparable to the edge of the cumuli when in summer time they flow to fill up the chasm which is in the centre or opening of the cloudy stratum.

This article of Father Secchi's brought forth a note from Sir J. F. W. Herschel, Bart., stating that he does not think the *willow leaves* are clouds in the ordinary sense of the word, he believes them to be *permanently solid matter*, having that sort of fibrous or filamentous structure which fits them when juxtaposed by drifting about and jostling one against another to collect in blocks, as *flue* does in a room. In answer to the question, Why are these, and these only, luminous? the author replies, Because they are solid and they float (at the level determined by their density) in *gaseous* or transparent liquid, or intermediate matter of immensely high temperature. The non-luminosity of the medium in which they float being quite sufficiently accounted for by supposing it of *colourless transparency*, colourless gases or transparent liquids giving off no heat from their interior. This is, in fact, the theory stated in Sir J. F. W. Herschel's article on Solar Spots, published in our Number for April, 1864.

The next communication consisted of a letter from Father Secchi, on the spectrum of the Great nebula in Orion; apparently not knowing that Mr. Huggins had already sent a paper on this subject to the Royal Society, the Reverend Father hastens to give the results which he has met with. The whole spectrum of this nebula reduces itself to three lines: one (*a*) tolerably strong, and which is seen wherever there



is nebulosity; the second (*b*) fainter; and the third (*c*) still more faint, and very near to (*a*). The group is situate between the Sodium

ray D and the Strontium blue line. Quoting an observation of Mr. Huggins in which it is shown that in α *Orionis*, there is no dark line corresponding to the above line *b* (coinciding with Frauenhofer's F). Father Secchi infers that we have in that star the bright ray which is found in the nebulæ. Can this star, he asks, be a body intermediate between the perfectly-formed stars and the nebulæ? In the discussion which followed this note, Mr. Huggins stated that he could not agree with the ingenious conjecture of Secchi, that the star α *Orionis* may be a body intermediate between a nebula and a fully-formed sun, because the dark line of absorption corresponding to F is wanting in its spectrum. The light of the star emanates, as its spectrum shows, from incandescent solid or liquid matter, and therefore necessarily contains rays of all refrangibilities, and it is the presence of bodies in its atmosphere which is indicated by the dark lines of absorption. The absence therefore of a dark line corresponding with F and also with one of the bright lines of the nebula is a proof, not that the gas in the nebula from which the light of that particular refrangibility emanates is present in the atmosphere of the star, but, on the contrary, that this particular gas is not one of the constituent elements at α *Orionis*. The closely-crowded lines of the spectrum of the star appear to prove that it contains elements as numerous as those which exist in the sun and in the brighter stars. The absence of the lines of hydrogen corresponding to C and F is scarcely a sufficient reason for degrading this star to a lower cosmical rank. At the request of the President, Mr. Huggins then gave an account of the most recent of his researches on the application of prismatic analysis to the light of the nebulæ. This was an examination of the Great nebula in the sword handle of Orion. The results have already been before our readers.

Some important steps have been gained and some real contributions made to exact science during the past year in the department of Meteoric Astronomy. A summary of these by A. S. Herschel, Esq., formed the next important communication made to the Society. As regards the height of shooting stars it appears from a comparison of several hundred observations dating from the end of the last century, that it may be stated respectively at 73 and 52 miles at first appearance and disappearance above the surface of the earth, with a probable error of not more than three miles. The average velocity of shooting stars in sixty-six instances is 35 miles per second. In this respect fireballs resemble shooting stars, but they differ from them in penetrating more deeply into the atmosphere; should they arrive within 20 miles of the earth's surface a violent concussion is usually produced, and stones are not unfrequently precipitated from the meteor. One of the most remarkable observations of a fireball on record was made by Dr. Schmidt, at Athens, on the morning of the 19th of October, 1863. A fireball of surpassing size and brilliancy was examined for 14 seconds by Dr. Schmidt, in a telescope with a magnifying power of eight diameters. The meteor was twin or double, attended and followed by a tribe of lesser meteors advancing side by side together, with parallel motions of translation, until the whole were extinguished. Respecting the origin

of aërolites, it has been found from a microscopic examination of the mixed minerals of which they consist, that their crystals differ in some essential particulars from those of ordinary volcanic rocks, but their consolidation must have taken place from fusion in masses of mountain size. The planetary velocity (at least 15 miles per second) of the meteor, which produced the recent aërolites of Orgueil, greatly exceeds the ballistic forces which can be supposed to reside on the surface of the earth or moon. We are therefore compelled to give a wider range to conjecture with regard to aërolites, and to suppose that they are projected from small planets near and within the orbit of the earth. Aërolites commonly fall in the daytime. They circulate round the sun in such countless numbers, or else they bear such close a relationship to the earth that they in all probability strike the earth daily in its path.

Mr. A. S. Herschel has also contributed an elaborate article on the "Radiant Points of Shooting Stars." We regret that it would be impossible to condense this article so as to give a good idea of the results at which the author has arrived.

The next paper was by J. Joynson, Esq., "On the Appearance of Mars." This subject has been so ably treated in the former part of this number by Professor Phillips, that no further mention of it is required here.

The Number of the 'Monthly Notices,' which contains a report of the March Meeting of the Society, is illustrated with a Photo-engraving of a Lunar Photograph, printed from a plate untouched by the graver. The picture, one of the most successful of its kind we have ever seen, has been taken by Paul Pretsch's process; but the original negative is apparently so perfect, that it is a matter for regret that Mr. Fox Talbot's photoglyphic process had not been adopted as a means of multiplication, as by this scarcely any of the fine definition would have been lost. It will be evident that by a process of this kind we have at our command a means of procuring prints of the lunar or solar surface, having all the permanence of ordinary engravings; and these methods, if used to reproduce photographs of large dimensions (thirty-eight inches in diameter, for example), would give such reliable charts as with any other mode of procedure it would be impossible to obtain. Much of the half tint is lost; but, nevertheless, so much of value is retained as to show that some such process is deserving of more general adoption for scientific objects than it has hitherto received.

At the conclusion of the meeting, Admiral Manners, who occupied the chair in the absence of the president, remarked upon the present activity and good condition of the Society. The communications are very varied in their character; the general range of the papers presented shows that observers and those who communicate their observations to the Society, are alert and alive to the importance of quick and rapid communication to this centre of astronomical science. It

is also a subject of congratulation to find that, whatever communications may be made, there are members present who are able to add to the value of the communications by their remarks, and who show that they understand the subject fully, and are quite acquainted with its progress.

At the April Meeting of the Society, a paper "On an Aluminium Bronze Transit Axis," and on "Certain New Methods of Adjusting Transit Instruments," was brought forward by Lieut.-Colonel A. Strange, F.R.S. Three years ago this gentleman presented to the Society a paper advocating the use of aluminium bronze, as a substitute for gun-metal in astronomical and surveying instruments. Since that time the alloy has been used in the large instruments now being made under his supervision for the great Trigonometrical Survey of India. The experience gained during the construction of these shows that the alloy is not fitted to receive graduation, both on account of the metal tarnishing more than was at first expected, and owing to the difficulty of obtaining absolute soundness of surface in casting of this metal. At first also the use of the alloy was threatened with further limitation. The early experiments in casting it in large masses resulted in internal air-holes to an extent to which other metals are less subject. This hindrance to the more extended use of the alloy has, however, yielded to scientific effort, and in proof of this statement there was exhibited to the Society the axis of a transit instrument formed of aluminium bronze. It was 33½ inches between the bearings; the central cube is 9½ inches by the side, and the thickness of the metal is only 0·15 of an inch; the whole weighing 56½ lbs. This admirable specimen of scientific founding was from the works of Messrs. Cooke, of York, who are one of the few optical firms (if not the only one) in England who do the whole of their own founding. Having regard to the great rigidity of the alloy (three times that of gun-metal), and the ingenious system of internal strengthening webs, there is little doubt that this is the stiffest transit axis in existence.

In the second part of his paper, the author submitted to the Society certain modifications which he proposed to introduce in the two transit instruments, to one of which the axis exhibited belonged. These came under the heads: I. Adjustments of axis for azimuth and horizontality. II. Mode of applying the level to the axis. III. Mode of examining the collimation error. This latter is intended to be effected by means of a mercurial trough, as being a preferable arrangement, for a travelling observatory, than by means of fixed collimators. As it is difficult in a field observatory to prevent tremors and disturbance of the mercury by currents of air, Mr. Cooke proposes the following arrangement:—A disc of glass having plane and parallel surfaces will float on the mercury and protect it from disturbance. The lower surface of the disc, in contact with the mercury, will form a brilliant plane-mirror to be used in the same manner as the usual unprotected surface of mercury. Certain mechanical conditions are imposed by the terms of the problem. 1st. The two surfaces of the disc must be plane; 2nd. They must be parallel; 3rd. The glass

must be of equal density throughout. Treating the disc by optical methods, Mr. Cooke expects to fulfil these conditions.

The next paper brought forward was a long mathematical discussion on the "Lunar Theory," by Professor Cayley. This defies condensation.

Mr. F. Abbott communicated a note on the variable star η *Argus* and the surrounding nebulæ. He is satisfied that continued changes are constantly taking place in this nebula, and that it is gradually breaking up into stars. In former notes he described the so-called dark space as resembling in shape a clearly-defined "crooked-billet;" it now assumes a very different form, and what is singular, Sir J. Herschel describes κ *Crucis* in glowing colours, "like a rich piece of jewellery;" but he is silent as to the colours of the stars around η *Argus*. In former notes the author mentioned many of them as being of a ruddy colour; but now they are of decided colours—blue, green, and red, the two former predominating. If the telescope is turned from one object to the other, it will be seen that, although Sir J. Herschel has not overdrawn the beauty of κ *Crucis*, the object η *Argus* is now much more superb, η standing out sharp and clear, amidst a large field full of richly-coloured gems with only a very small patch of nebulous matter seen under the telescope. In February last, during the period of full moon, the position of η *Argus* was distinctly seen with the naked eye, by the white light that surrounded it, although the star could not be seen as a point, nor could the position of *Nebicula Major*, *Nebicula Minor*, the *Via Lactea*, or any other nebula be seen at the time. This appears plain proof that the objects composing the nebula around η *Argus* are now of a larger character, and more refulgent than nebulous matter in general.

We can make the same remarks with reference to a paper, which was next read, by C. G. Talmage, Esq., "On an Appearance presented by the Spots on the Planet Mars," that we did in respect to the paper by Mr. Joynson on the same planet.

The concluding papers were devoted to observations on a large comet, which was visible at the commencement of the year in the Southern hemisphere. They are by J. Tebbutt, jun., Esq., Windsor, New South Wales; R. C. J. Ellery, Esq., Melbourne Observatory; and F. Abbott, Esq., Hobart Town.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

M. Planchon has made some observations on the Flora of Montpellier, from the 15th century up to the present date. The neighbourhood of that city possesses special interest as regards botanical geography. For three centuries celebrated botanists have made excursions in the locality, and have left traces of their observations in their writings and herbaria. By this means we can observe the introduction and disappearance of certain species, such at least as have well-charac-

terized forms. Moreover the traffic in wool has introduced into the place called Pont de Juvenal foreign plants, which have frequently attracted the notice of botanists. M. Planchon has made use of numerous documents already published, as well as of his own observations, to bring out the effects produced on the vegetation of Montpellier, by the various causes which have had a tendency to alter it since the 16th century. Around Port Juvenal 458 species have been successively introduced. The botanic garden of Montpellier has contained, from the time of Richer de Bellerat to the present day from 1,200 to 5,500 species, the seeds of which might accidentally be scattered beyond its boundaries. The ballast of ships has been deposited in many littoral situations, and that ballast in many cases contained seeds. The wind, birds, and currents, have transported seeds from various places, far and near. Many botanists have scattered seeds in different places. At the same time, culture, drainage, the destruction of forests, and the avidity of collectors, have caused the disappearance of many species. Notwithstanding all these causes of change in the Flora, the following are the definite results: Five species at most have disappeared from the neighbourhood of Montpellier, and not one of them has been destroyed by botanical collectors. This shows how needless were the fears of those who lately protested against the prizes for collections offered by the Horticultural Society of London. The attempts at introduction by man have had effect only in establishing three aquatics, of which *Jussiœa grandiflora* is the most extended. Culture has brought into the country eight species, but all of these have been limited to the place where they were introduced. The import of wool has only given rise to the appearance of one species (*Onopordum virens*). Ballast has brought 3 species, which are still very limited. There are only 15 species which an observer, ignorant of their origin, might look upon as indigenous. Of these 15 species, 11 come from America, 1 from the Cape of Good Hope, 2 from the East, and 1 from Europe. The American species most diffused are *Œnothera biennis*, *Erigeron canadense*, *Amaranthus albus*, *A. retroflexus*, *Xanthium spinosum*, *X. macrocarpum*, and *Bidens bipinnata*. Man has almost always been the direct or indirect agent in the introduction of the species.

M. Planchon has also studied the fossil Flora of Montpellier. He finds that changes have taken place in the Flora at a former epoch. He has found in the quaternary formation of Montpellier 30 species, all of which exist at the present day, the greater part in the same locality. The laurel was the predominating shrub. It no longer exists in a wild state round Montpellier; but it was found two centuries ago in the locality of Castelnau, and it exists still at the present day on the northern face of the Pic de St. Loup and on the rock of Arcs. Three species out of 30 are no longer found in the country; these are,—*Fraxinus Ornus*, *Pinus Laricio*, and *Acer Neapolitanum*, the nearest localities for which are Corsica or Italy. On the contrary, several species, abundant at present in the dry gravelly soils of Montpellier, have not been found in the quaternary formations; for instance, *Quercus coccifera*, species of Cistus, Rosemary,

Thyme, and Lavender. Planchon has noticed the same fact in similar formations in Provence and Italy, so that it is not the result of a purely local change. The plants of dry localities seem to have become more rare in the South of Europe during the quaternary epoch. In other words, the humidity appears to have been greater, and more generally diffused, as might have been expected in a glacial epoch. When we compare the formations observed in Provence by Saponta, and in Italy by Gaudin, and those at Montpellier, we find that in the latter all the species exist at the present day, whilst in the former there is a mixture of extinct species. The quaternary formations at Montpellier appear, therefore, to belong to a more recent epoch.

In the Montpellier formation we find figs similar to those of the wild fig and leaves of the vine, which indicate the existence of these plants in the South of Europe, anterior, in all probability, to culture. On the other hand, the Olive is wanting.

It is stated that in France cases have occurred in which inoculation with Oidium Tuckeri, or the fungus which causes the vine disease, has proved fatal to human beings. Wounds accidentally made with the instrument used for cutting off the diseased vine shoots have presented, according to Dr. Collin (Medical Inspector of the Mineral Waters of Saint-Honoré, Nièvre), marked evidence of poisoning. In some cases the persons thus wounded have died in from twenty to twenty-five days, notwithstanding the most energetic treatment. Messrs. Desmartes and Bouché, of Vitrany, have also concluded, from their experience, that deleterious effects are produced by the Oidium, but they seem rather disposed to establish a coincidence between the epidemic development of the Oidium and a greater frequency of certain forms of inflammation of the mucous membranes. The subject has been submitted to the consideration of the Academy of Medicine in Paris.

Dr. Alexander Dickson has recently examined the morphological constitution of the Andrœcium of Mentzelia, and its analogy with that of certain Rosaceæ. He gives the following result of his investigation of the development of the stamens in Mentzelia aurea. From the fact of the greater number of the stamens not appearing until after the development of the carpels, as well as from a consideration of the peculiar arrangement of the stamens, he believes that here the Andrœcium really consists of five compound and confluent stamens superposed to the sepals. Dr. Dickson is of opinion that the only essential difference between Mentzelia and its allies, on the one hand, and Loasa and its allies on the other, is, that in the former the evolution of staminal lobes is centripetal, in the latter centrifugal; both series of genera agreeing in having five compound stamens superposed to the sepals. This difference in staminal evolution does not appear to Dr. Dickson sufficient to justify the breaking up of the old order Loasaceæ, as has been done by Payer in his 'Leçons sur les Familles Naturelles des Plantes.' In the Rosaceæ, where Payer had recognized a similarity in staminal evolutions to the Mantzeliæ, Dr. Dickson believes that those Andrœcia whose development has been examined may

be arranged under two types :—I. Aremonia type; stamens superposed to the sepals, with or without a true corolla. Examples: Aremonia, Agrimonia, Sanguisorba, Poterium. In Aremonia and Sanguisorba the stamens are simple; in Agrimonia they are compound and distinct; and in Poterium, compound and confluent. II. Alchemilla type; stamens alternate with the sepals; no true corolla. Examples: —Alchemilla, Rubus, Rosa, Geum, Fragaria, &c. In Alchemilla the stamens are simple. In Rubus and the others the stamens are compound and confluent, with their terminal lobes developed as petaloid staminodes (the petals ordinarily so called) analogous to the petaloid staminodes forming the inner corolla of Bartonia, an ally of Mentzelia.

Dr. Thomas Anderson reports on the state of the Cinchona plantations at Darjeeling, in February, 1865. He states that the month has been less favourable than January, as the cold, which has been quite as great as in January, has been accompanied with a very dry state of the atmosphere. Hail fell on the 3rd of the month and rain on five days, but with the exception of the 25th and 26th of the month only in slight showers, which did no benefit whatever to the Cinchona. The slight increase in growth took place almost entirely during the last five days of the month, with the exception of the lowest plantation, where about the 17th the plants began to show the first symptoms of the return of spring. At the first plantation (5,500 feet above the sea) the temperature has been very low, causing the destruction of at least three plants of Cinchona Pahudiana, and affecting a few of Cinchona officinalis. At the second plantation (4,350 feet above the sea) hoar-frost occurred in several nights in February, but no damage has been done to any plants at this elevation. Observations on the temperature of the air have been made with more or less regularity during the month at the 3rd, 4th, and 5th plantations. At the fourth plantation (2,550 feet above the sea) the maximum and minimum temperature in the shade was recorded every twenty-four hours during the month. The mean maximum temperature for the month at this elevation was 66°18, the mean minimum 47°93, and the monthly mean temperature 57°05. At the fifth, the lowest plantation (altitude 1,825 feet) fewer observations were made, as the plantation was visited daily by the person observing. The results from the detached observations there give 71°56 as the mean maximum, and 47°77 as the mean minimum, 59°5 as the mean temperature of the month.

The total number of plants, cuttings, and seedlings in the Government plantation at Darjeeling, on 1st February, 1865, is as follows:—Cinchona succirubra, 4,780; C. Calisaya, 23; C. micrantha, 944; C. officinalis and vars., 19,329; C. Pahudiana, 5,092—total, 30,168.

Dr. Moore, of Glasnevin, has recently visited the station in Galway, for Nectinea intacta. He saw about 40 plants in the locality; they grew on a dry bank close to limestone.

Dr. Dickson thinks that there are two marked varieties of Pinguicula vulgaris, in Scotland, distinguished by the size and form of their leaves, as well as by their flowers.

The Pitayo Cinchona has attracted attention of late, and a Report

has been drawn up on the subject by Mr. Robert Cross,* of which the following is an extract:—

Mr. Clements R. Markham having been impressed with the importance of procuring seeds of the species of Cinchona which grow at and near Pitayo, New Granada, obtained the sanction of the Secretary for India to employ Mr. Cross in the service. The first writer who described the country round Popayan and Pitayo was the Spanish conquistador, Cieza de Leon. He accompanied the invading discoverers, who, starting from Darien in 1536, ascended the valley of the Cauca, and reached Popayan. The next author who treated of this region was the humane and generous but unfortunate Adelantado Andagoya, who was at Popayan in 1544. Ulloa, in his travels, gives a brief general account of the Popayan province. The only modern writers who have preceded Cross are Humboldt, Caldas, Karsten, and Vigne. Humboldt crossed the paramo of Quindiu, ascended the valley of the Cauca to Popayan in 1801, and went thence to Pasto and Quito. During his stay at Popayan he made an excursion to the village of Purace. The learned Caldas was a native of Popayan. He was a good botanist and an excellent observer, and he knew the country well. Most of his writings are, unfortunately, still in manuscript, but some of them have been printed in the 'Semanario de la Nueva Granada,' amongst which there is a very valuable geographical memoir written in 1807. Dr. Karsten was for some years in this part of South America investigating the botany of the Andes. He made notes on the medicinal Cinchona barks of New Granada. Finally, Mr. Vigne travelled for his amusement from Quito to Bogota, going over exactly the same route as Cross, and his travels were published in 1863. Among these writers, Caldas and Vigne are the only ones who have gone over the same ground as Cross, and no one had given any account of the actual Pitayo forest previous to Cross's visit. Mr. Cross remarks that most persons who have written on the Cinchona of the Andes represent it as flourishing amidst perpetual torrents of rain and mist, without scarcely ever enjoying a moment of sunshine. He states that this is a mistake. No Cinchona could live in such a climate, nor, even if planted in similar situations, could the trees ripen their seeds, for a certain amount of dry weather and sunshine is necessary for the ripening of the capsules, and for their bursting in order that the seeds may fall to the earth. The Cinchona climate is certainly moist for about six or eight months of the year, and in cultivating this plant it is expedient to seek very humid situations, because the mountains of India do not appear to receive the same amount of moisture as the lofty elevations in America. Nevertheless it will be understood that the natural climate of the commercial Cinchona has been misrepresented by most South American travellers. The Pitayo Cinchona differs essentially from the C. lancifolia of Karsten in being a more slender tree, often found formerly from 60 to 70 feet in height, but rarely more than 18 inches or 2 feet in diameter, with very slender branches, bearing small lanceolate leaves, which before falling always assume a purple or deep red colour. The C. lancifolia to which Karsten refers extends over a wider tract of country than any other Cinchona on the Andes. This tree, however, is much more massive, and bears considerably larger leaves than those of the Pitayo Cinchona. This large-leaved Cinchona inhabits the western slopes of the Cordillera Orientale, in situations presenting conditions favourable for its development, between Pasto and the city of Santa Fè de Bogota; while the finer kinds of Pitayo bark are limited to a

* 'Report to the Under Secretary of State for India on the Pitayo Cinchona,' &c. By Robert Cross. 8vo. London, 1865. pp. 60.

few square miles of steep forest-covered slopes to the northward of the volcano Purace, which belongs properly to the central Cordillera. The map of the Cinchona region of New Granada, lately made for Dr. Weddel, is very incorrect. It represents certain tracts of country as mountainous, and as covered with Cinchona forests, while in reality they are hot arenaceous plains, or savannas covered with low spreading leguminous trees, where no Cinchona ever grew. Karsten states that the bark is not taken from the roots of the C. lancifolia, which, in most instances, is true; but this is not the case with that of Pitayo, the bark from the roots of which is much more valuable than that from the trunks and branches. Further, he asserts that the C. lancifolia is never likely to become scarce, and that the continual cutting of the Cinchona trees will rather augment than diminish the number of plants, and this may be true concerning his C. lancifolia, about which no one cares much, as the yield of quinine is often too small to cover the expense of collecting; but as regards the Pitayo bark there is one thing very certain, that at the present time there is more difficulty in collecting one pound than there was formerly in collecting one hundred-weight. The Pitayo bark will very probably be found the best of all the species for cultivation, as it is said to grow very rapidly, which is a matter of great importance. It may certainly be barked when it is six feet high, although it would not be an advisable practice to do so before the trees are at least 30 feet high. Bark taken from large trees in Pitayo was said to give nearly 4 per cent., while bark taken from the roots of the same trees gave 5 per cent. of quinine. All the bark taken from Pitayo is said to be sent to France. The bark sold in England under that name is not true Pitayo bark, but comes from the mountains which border on the valley of the Magdalena, and from Almaquer and Pasto, and is certainly different from the C. lancifolia of Karsten, which as regards quality is very inferior to that of Pitayo. True Pitayo bark may be known in England by not being much thicker than common window-glass—because it is all taken from small plants, the large trees having been destroyed long ago, and by its being full of earthy particles, on account of so much bark being taken from the roots of the plants. The Cinchona alluded to by Karsten is rarely collected when less than one-fourth of an inch in thickness, but it is sometimes seen nearly an inch thick after the epidermis has been scraped off. Professor Jamieson, of Quito, analyzed the Pitayo bark brought from the locality from whence the seeds were taken, and found it to contain 3·2 per cent. of quinine. There is therefore little doubt that this species, and the Cinchona officinalis of Loxa will prove among the best for cultivation. The climate is like that of Loxa, and even the vegetation of both regions bears a close resemblance to each other. The Andes of South America, from the southward of Loxa to the city of Santa Fè de Bogota, present great diversities of character, and even each particular tract of country possesses its own peculiar and distinctive features. Around Loxa many of the mountain ridges appear as if they had been scraped from top to bottom, and they are separated by deep ravines, on whose naked and almost perpendicular sides grow only a few stunted Cacti and Agaves. To the south-west of the valley of Catamayo, dry, rainless deserts extend to the frontier of Peru. However, on passing to the northward of Assuay the mountainous regions are covered with a dense vegetation; and above the forest limit are extensive grassy paramos, while higher still rise rounded elevations, or conical peaks, covered with perpetual snow. Beyond Pasto, the loftier regions bear an arborescent vegetation; but the hot, low-lying plains are mostly covered with coarse grass, or low-spreading Leguminosæ. From this point, until one reaches the great valley of the Magdalena, the mountainous region presents

a most savage aspect of stupendous precipices, which form a kind of wall along the base of the eastern and central Andes. Throughout this vast territory, but especially along the course of the central Andes, runs a long line of burning mountains, active spouts of hot mineral water and sulphurous vapour, and bubbling mud volcanoes. Don Narciso Lorenzano remarks that the principal motive which induced the Government of India to commence Cinchona cultivation, after overcoming so many difficulties, was the fear that the Quina trees would be extirpated in consequence of the waste that is allowed in the woods, where they are destroyed by the barbarous method of pulling up the roots. Fortunately this destructive method, which, without any doubt, would extirpate this precious plant in a few years, is only practised in the forests of Pitayo, where it is due to the immoderate desire for making money which has taken possession of the Indians, who own the greater part of the land. But in none of the other establishments for the collection of bark in New Granada has a similar practice been adopted. On the contrary, beneficial rules are observed for the conservancy of the woods. The method consists in leaving a part of the trunk, about three feet in height, whence shoots may sprout, and in clearing away the surrounding trees to enable the rays of the sun to penetrate. By this means most of the trees that are cut down quickly shoot up, and, the rays of the sun penetrating to the cleared ground, the seeds which fall from the trees germinate freely. This result gives us full confidence that the good kinds of Quinas which exist in this country will be permanently preserved. We may conclude that there need be no fear that humanity will see itself deprived of this precious medicine, seeing that as well in Bolivia, as in Peru, Ecuador, and New Granada, the rule of cutting the bark according to a fixed plan is observed, and care is taken that the woods are replenished with increased numbers of plants of the best species, while some experiments have been made in forming plantations on lands where the best conditions for their growth are found. From all this we hope that in a few years we may see valuable results.

M. Thielens, in a communication on the plants of Belgium, mentions the following additions to the Flora in 1864 :—Asperula glauca, Corallorrhiza Halleri, Carex depauperata, C. paradoxa, and C. ornithopoda.

On examining the flowers of Fumariacæ in their early development, M. Godron finds them quite regular, but flattened from before backwards, as if they were compressed between the axis of inflorescence and bract. They preserve this regularity in Diclytra, Adlumia, and Dactylicapnos. In these three genera, the two external petals, placed laterally, undergo during development an important modification. The base of each is prolonged into a short and rounded spur, and the two nectariferous appendages become finally quite regular. The two sepals placed superior and inferior, also remain perfectly regular.

Again in the Genera Fumaria and Corydalis, only one spur is developed so as to render the flower irregular. This spurred petal becomes larger than its antagonist. Mr. Godron has examined Corydalis solida, Sm. and C. cava Schweigg, in their early condition, while still under ground. He traces the abortion of one of the spurs in the petals to the flowers during their development being compressed at the base on one side only. In this way development of

the nectary and its appendages is prevented. M. Godron made experiments with the flowers of Diclytra, so as to compress one of the petals at the base during its development, and he thus rendered it like Fumaria with a single spurred petal.

In Diclytra and Adlumia the spurs develop at a later period than in Fumaria, and in such a way that the raceme in elongating separates the flowers from each other, and allows the free and equal formation of spurs.

The regular form sometimes continues in the Fumaria and Corydalis. M. Godron has seen Corydalis solida assuming a pelorian form by two or even four petals becoming spurred or calcarate. The flowers in this case are sterile.

Inflorescence of Cruciferæ.—Bracts are generally wanting in the racemes of Cruciferæ. In some of the characteristic species we find bracts occasionally in the lower flowers. In Sisymbrium supinum, L., all the flowers are produced with a pinnatifid bracteal leaf, and the same is the case with Sisymbrium hirsutum, Lagasc.

Brassica oleracea has been seen with large oblong bracts in connection with its lower flowers, while smaller bractlets occurred at the upper part of the raceme. Similar phenomena have been observed in Erysimum cheiriflorum, Wallr. Arabis Turrita, L., Hesperis matronalis, L., Bunias orientalis, L. Sometimes the lower and middle part of the inner face of the bract becomes united to the base of the peduncle. This has been noticed in Iberis sempervirens, L., and in other Cruciferous plants. Sometimes when the bracts are completely wanting, there are traces of the decurrence of leaves at the base of the naked peduncle.

Godron says that, 1st, the quaternary type, with two rows of stamens, is the normal condition of Cruciferæ; 2nd, that the absence of bracts, and the greater or less flattening of the peduncle; the more or less depressed form of the flower bud; the slight irregularity of the calyx, the absence of two stamens in the outer verticil of the andrœcium, and often of the two glands on which they rest, and finally the abortion of two carpellary leaves, are determined by a pressure which is exercised from within outwardly on the flowers of Cruciferæ; 3d, this pressure is owing to the accumulation of flowers which are developed in great numbers at the summit of the Inflorescence in its corymbiform state, and which are naturally restrained or hindered in their evolution, as well as to the resistance which is presented to this expansion by the accumulated leaves which surround the inflorescence at its origin.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Except in organic chemistry, and here only in those researches which interest but the most advanced chemists, there is little of importance to report. It would be wrong, however, in an English Journal to pass without mention the valuable papers presented to the Royal Society by Messrs. Frankland and Duppa, "On the Acids of the Lactic Series, and on the Synthesis of Butyric and Caproic Ethers from Acetic Ether." No less valuable is the paper "On the Hydrocarbons of the Series $C_n H_{2n} + 2$," contributed by Mr. C. Schollemmer. All these papers throw important light on the constitution of the so-called organic compounds, and will be studied with much interest by all who watch the wondrous development of this branch of chemistry.*

In inorganic chemistry there are a few things of scientific and technical interest to which we may more particularly refer. As a curious experiment and striking illustration of the play of affinities, we may notice a reaction described by J. Schiel.† Into a stoppered bottle filled with perfectly dry chlorine, he introduces a sealed tube containing peroxide of silver. He then shakes the bottle and breaks the tube, and now in a few seconds finds that the bottle is filled with oxygen, which the chlorine has replaced. Peroxide of silver is rather difficult to produce, but the same experiment may be shown with the oxide, a longer time being allowed for the displacement of the oxygen. To succeed, perfectly equivalent amounts of chlorine and the oxides must be employed, or the latter must be in excess.

A new and very easy way of obtaining oxygen has been recently described by Fleitmann.‡ He takes a clear solution of ordinary chloride of lime (hypochlorite) and adds to it a mere trace of freshly-prepared moist peroxide of cobalt, and then heats the mixture to 70° or 80° C. At this temperature oxygen is freely evolved, and the whole of the hypochlorite is reduced to chloride of calcium. According to the author the peroxides of cobalt have a variable composition, and to explain the above reaction he supposes that a lower oxide abstracts oxygen from the hypochlorite to form a higher oxide, which is immediately decomposed again into the lower oxide and oxygen. The action of the oxide of cobalt is thus seen to be exactly similar to that of nitric oxide in the manufacture of sulphuric acid.

In connection with the above we may mention that Winkler appears to have proved the existence of cobaltic acid, CoO_3,§ which he finds to be a very unstable body. A potash salt of the acid is obtained by boiling one part of spongy cobalt with one part of caustic potash dissolved in three parts of water, until a dark blue solution is procured. The addition of sulphuric acid to this solution liberates oxygen,

* All the above papers will be found in the 'Proceedings of the Royal Society,' vol. xv. pp. 164, 191, 198.

† 'Annalen der Chemie und Pharmacie,' December, 1864.

‡ Ibid., April, 1865, pp. 64.

§ 'Journal für prakt. Chemie,' vol. xc. p. 213.

protoxide of cobalt being precipitated. Sulphurous acid is converted into sulphuric, which combines with the protoxide of cobalt.

The decomposing action of lead upon pure water has been illustrated by an experiment of Stolba,* who found that on boiling pure water with a relatively large quantity of lead in foil or granulated, hydrogen was somewhat freely evolved, and a strongly alkaline fluid remained in the flask.

Runge has described † the action of sodium amalgam on some metallic salts. Ferric and chromic chlorides he found to be quickly reduced to ferrous and chromous chlorides; in time the whole of the chlorine was withdrawn and iron and chromium amalgams were obtained. The chromium amalgam was a fluid and very unstable compound.

One of the most original and important recent contributions to chemical knowledge we have to notice is the paper presented by Mr. Gore to the Royal Society "On the Properties of Liquefied Hydrochloric Acid Gas." Anhydrous hydrochloric acid the author found to have no acid properties. Solid extract of litmus dissolved but slightly in the liquefied acid forming a purple or inky solution. Metals which dissolve easily in a dilute solution of the acid were scarcely affected; even caustic lime remained in the liquid unattacked. Those oxides attacked were but slowly converted into chlorides; the same was observed with the carbonates, but no bubbles of gas were seen to escape from the liquid. The latter circumstance may be easily accounted for, however, since the author has shown in a former paper that hydrochloric and carbonic acids may be condensed together, forming one liquid.

The properties of the new metal, Indium, discovered by Reich and Richter (*see ante*, p. 87), have been further investigated by Winkler.‡ The metal resembles platinum in appearance. It is soft like lead, and may be easily cut with a knife. Heated to bright redness, it volatilizes and burns with a blue flame, forming an oxide InO, which is deposited as a yellow powder. The reactions of the metal, as given by Winkler, are much the same as those given by the discoverers; but the determinations of the atomic weight differ considerably. Reich and Richter gave the atomic weight as 74·14 ($O = 16$); but Winkler's experiments lead to the number 35·918 ($O = 8$). Further researches on this metal, which has hitherto been only obtained in very small quantities, will, no doubt, clear up these discrepancies.

A paper of considerable importance was contributed to the Literary and Philosophical Society of Manchester, by Dr. F. C. Calvert and Mr. Johnson, and will be found in the 'Chemical News,' vol xi. p. 171. It relates to the action of sea-water on certain metals and alloys, and therefore will interest all concerned with shipping. We may pass over the laboratory experiments, and quote only the results of those made by immersing plates of the metals, 40 centimetres

* 'Journal für prakt. Chemie,' 1865.
† 'Chem. Central Blatt,' No. 17, 1865.
‡ 'Journal für prakt. Chemie,' No. 1, 1865.

square, in the sea. The plates were left suspended in the water by a flax rope for a month. At the end of this time it was found that the following amounts of the metals had been dissolved :—

	Grammes.
Steel	105·31
Iron	99·30
Copper	29·72
Zinc	34·34
Galvanized Iron	14·42

The results obtained with brasses, and Muntz's metal, show that these are much less acted on than pure metals, and there can be no doubt, the authors say, that shipowners derive great benefit from employing them. The great loss in the case of iron shows the necessity for a good protective coating for vessels made of that material.

Another paper of much technical interest was presented to the above-named Society by Messrs. Caro and Dancer. It was "On the Injurious Action of Alkalies on Cotton Fibre." A paper on the same subject, and evidently based upon a study of the same material, was read before the Chemical Society, by Dr. F. C. Calvert, and will be found in our account of the Proceedings, given below. It will be sufficient to say here that the writers are in accord as to the injurious action of alkalies on cotton, and manufacturers will, no doubt, discontinue the use ofsilicate of soda as a dressing.

Proceedings of the Chemical Society.

In the course of the last three months several papers of considerable practical interest have been communicated to the Society. The first of these was by Dr. F. C. Calvert, "On the Action of Silicate and Carbonate of Soda on Cotton Fibre," in which it was shown that cotton fabrics, impregnated with the silicate, became in the course of time perfectly rotten. Two explanations of the action were suggested. 1. The silicate decomposed by the carbonic acid of the atmosphere deposited silicate in the cotton-cells, distending and rending the cells, and so weakening the strength of the fibre, while the carbonated alkali, which has also an injurious influence on cotton, remained in contact. Secondly, it was suggested by Mr. W. Crum, that cotton fibre itself might have the power of fixing silica without the intervention of carbonic acid, and thus a caustic alkali would be liberated on the cotton.

Mr. Abel, from the results of experiments he had made upon canvas, believed that the cause of the rottenness was mechanical, and not chemical, since fabrics impregnated with a neutral salt, like sulphate of magnesia, became weakened, no doubt by the deposition of solid matter within the fibre, and the distension caused by crystallization—an opinion which was supported by Dr. Frankland, who quoted the familiar fact that the strength of cotton and linen is impaired by the action of frost.

At the same meeting Dr. Calvert showed some Crystallized Hydrate of Phenic Alcohol, or Monohydrated Carbolic Acid, and gave some reasons for preferring to regard the monohydrated oxide of phenyl as

an alcohol, and not as an acid. The compounds which this body forms with alkalies are of a very indefinite character. It may be distilled without loss from an alkaline solution, and although it absorbs ammonia with avidity, it parts with it again when heat is applied. When, however, the ammoniacal compound or mixture is heated under pressure, aniline and water are formed. The so-called acid and the hydrate here spoken of both dissolved oxide of lead, and seem to form a definite compound $C_{12}\,H_6\,O_2+2\,P_b\,O$.

A paper, by Mr. Church, on some Cornish minerals, communicated the same evening, will be found noticed in its proper place.

A note by Mr. C. L. Bloxam, on the action of Chlorine upon arsenious acid made known the curious fact that in the reaction of these two bodies at a moderate heat, one portion of the arsenious acid, becomes oxidized at the expense of another, and thus terchloride of arsenic and arsenic acid are formed. The latter combines with arsenious acid to form a transparent glass, having the composition $2\,As.O_3$, $As.O_5$.

At another meeting Mr. Bloxam read a paper "On the action of Hydrosulphate of Ammonia on freshly-precipitated Sulphide of Copper," by which it seems that a double compound of sulphide of copper and sulphide of ammonium is formed. It is a very unstable salt, which by great care can be obtained in vermilion-red crystals, very like those of chromic acid.

At the same meeting the same gentleman read some interesting and valuable notes on qualitative analysis. The first related to the reduction of binoxide of tin by cyanide of potassium. Sulphate of potash is often found as an impurity in commercial cynanide of potassium, and when binoxide of tin is fused with such a mixture sulphides of potassium and tin are produced, which combine together and dissolve when the fused mass is treated with water, thus causing a considerable loss of tin. In some cases both stannic and stannous sulphides are formed, and when commercial cyanide is an anaylsis both of these should be looked for; the latter will be left as a black powder when the fused mass is dissolved in water, and the former will be separated from the solution on the addition of hydrochloric acid.

Another note related to the detection of Zinc. Mr. Bloxam recommends that the supposed sulphide of zinc precipitate should be dissolved off the filter with hot dilute nitric acid, and the solution mixed with a very minute quantity of nitrate of cobalt. The whole should then be precipitated with carbonate of soda, the product collected in a filter, washed, dried, and afterwards incinerated on platinum foil, by which the green compound confirmatory of the presence of zinc is obtained. If the green colour should not be apparent at first, it will become visible when the residue is moistened and crushed. In this way the Professor said that $\frac{1}{10000}$th part of zinc in solution might be identified.

When testing for magnesia in the filtrate, from the ammonia and sulphide of ammonium precipitates with phosphate of soda, a flocculent precipitate sometimes makes its appearance at once, and obscures the magnesian reaction. This precipitate Professor Bloxam has

found to be phosphate of alumina, formed in consequence of the slight solubility of alumina in ammonia, and in sulphide of ammonium.

Lastly, the same author read a note showing that in minute and exact analyses the mineral constituents of filter paper must be taken into account. A careful analysis of the ash of such paper has shown it to consist chiefly of clay and carbonates of lime and magnesia, with ferric oxide ; but besides these, sulphates of potash, soda and lime, with traces of phosphoric acid and oxides of cobalt and lead, were present.

In an interesting communication "On the Periodides of some Organic Bases," Mr. Tilden made known the existence of several new compounds having a constitution like that of the iodo-sulphate of quinine, and possessed of similar optical properties. For a full account of these bodies we must refer the reader to the 'Journal of the Chemical Society' for April.

A paper, read by Dr. J. H. Gladstone, "On the Specific Refractive Energies of the Elements and their Compounds," belongs to Physics rather than Chemistry, and will be noticed in another place.

The last paper we can notice was by Dr. Miller, "On some Points in the Analysis of Potable Waters." The greater part of this valuable paper was devoted to an account of the method pursued by the author in the determination of organic matters. It is well known that the greatest discrepancies sometime occur in the statements of different chemists regarding the same water, and Dr. Miller described the precautions necessary to ensure exact results by the incineration process. He also described at some length the mode of determining the amount of oxidizable organic matter by means of a standard solution of permanganate of potash. This reagent, although it does not discriminate between different kinds of organic matter, still affords tolerably precise indications of the quantity present, and moreover is most readily acted on by those matters which are most objectionable in water. In reply to the objection that the presence of nitrites might affect the test, Dr. Miller said that it was easy to discriminate between these and actual organic matters, since the former decolorized the solution instantly, and the action of the latter was progressive ; so that the pink solution might be added until the water became permanently coloured, and the subsequent slow decolorization might be set down to organic matters. As a positive test for the presence of nitrites, the author gave that proposed by Dr. Price, *viz.* a solution of icdine of potassium and starch with a drop of dilute sulphuric acid, but we may state that this test is open to a fallacy, since iodine is set free when chlorides and nitrates are present, and nitrites altogether absent. For the determination of nitrates, Dr. Miller recommended the process of Dr. Pugh, which is no doubt well known to our readers. In the discussion which followed, the advisability of adopting a uniform method of stating the results of an analysis was strongly dwelt upon by several chemists, and it is to be hoped that the publication of this valuable paper will contribute to that end. It was announced for publication in a forth coming number of the 'Journal of the Chemical Society,' and we shall probably have occasion to refer to it again.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

A most important contribution to Natural History as well as to Entomology has just been published by the Linnean Society. It is an article by Mr. A. R. Wallace, "On the Phenomena of Variation and Geographical Distribution, as illustrated by the Papilionidæ of the Malayan Region." It is of course written from the Darwinian point of view, but is especially valuable as embodying the observations made by the author on that particular family of butterflies during his long and arduous explorations in the Eastern Isles. We can only give a brief abstract of a paper which occupies nearly 71 quarto pages, and regret that our space will not permit a more detailed analysis.

The greater sensibility of the diurnal Lepidoptera to modifying causes is well known, and therefore in no other families of insects is there so much difficulty in determining what are species and what only varieties. The definition of Pritchard, that "separate origin and distinctness of race, evinced by a constant transmission of some characteristic peculiarity of organization," constitutes a species, is adopted by Mr. Wallace, so far as when the difference is not confined to a *single* peculiarity, and leaving out the question of origin. To this it may be objected that practically it will be all but impossible to tell what peculiarities are constant, or transmitted from generation to generation, in the great mass of specimens that may come under the eye of the Entomologist. Besides, 1st, *simple variability*, Mr. Wallace distinguishes—2nd, *polymorphism* (or *dimorphism*); 3rd, *local forms*; 4th, *coexisting varieties*; 5th, *races* or *subspecies*; and 6th, *true species*. By *simple variability* the author includes "all these cases in which the specific form is to some extent unstable." Closely allied to some of these variable species are others, which, though only slightly differing from them, are constant and confined to limited areas. These local forms are treated by Mr. Wallace as distinct species. *Polymorphism* or *dimorphism* implies the coexistence of two or more distinct forms in the same locality, "occasionally produced from common parents," the union of these distinct forms not producing intermediate varieties, but reproducing the parent forms unchanged. Several curious cases (generally confined to the female sex) are given, but the phenomena will be more clearly understood by the following illustration:—Suppose "a blue-eyed, flaxen-haired Saxon man had two wives, one a black-haired, red-skinned Indian squaw, the other a woolly-headed, sooty-skinned negress,—and that instead of the children being mulattoes of brown or dusky tints, mingling the separate characteristics of their parents in varying degrees, all the boys should be pure Saxon boys like their father, while the girls should altogether resemble their mothers. This would be thought a sufficiently wonderful fact; yet the phenomena here brought forward as existing in the insect world are still more extraordinary; for each mother is capable not only of producing male offspring like the father, and female like herself, but also of producing other females exactly like her fellow-wife, and alto-

gether differing from herself." *Local forms* or *varieties* are, it appears to us, scarcely distinguishable from races or subspecies, except that the differences are slighter, but surely this is not sufficient to constitute a distinct phenomenon. The *coexisting variety* "is a somewhat doubtful case." It is "when a permanent and hereditary form exists in company with the parent or typical form, without presenting those intermediate gradations which would constitute it a case of simple variability." This can only be distinguished from dimorphism by direct evidence of the two forms breeding separately. *Races* or *subspecies :* "these are local forms completely fixed and isolated," and, as we have already said, are treated by Mr. Wallace as species. As, however, it is admitted that "these may and probably have been derived from a common stock," it seems more convenient to use the word *subspecies* than to obliterate the distinction between an ordinary well-marked form and what is avowedly often only a slight though permanent modification, by calling both *species*, albeit it may be desirable in some cases that they should have a specific name.

Species.—Here Mr. Wallace, notwithstanding the Pritchard definition, confesses that "we have no means whatever of distinguishing so-called 'true species' from local forms and varieties; but the experience of any one who has studied any large family of insects will confirm this assertion that in many instances 'not single species but whole groups' have, from the accumulation of materials, been proved to have 'no definite specific limits.'"

This is, however, scarcely sufficient to prove the origin of species by variation and selection, though it shows that the permanence of species is not to be depended on within any limits than can at present be defined.

So far as the phenomena of variation among the Papilionidæ are influenced by locality, Mr. Wallace has come to the following conclusions:—1, the species of the Indian Region (Sumatra, Java, and Borneo) are almost invariably smaller than the allied species inhabiting Celebes and the Moluccas; 2, the species of New Guinea and Australia are also, although in a less degree, smaller than the nearest species or varieties of the Moluccas; 3, in the Moluccas themselves the species of Amboyna are the largest; 4, the species of Celebes equal or even surpass in size those of Amboyna; 5, the species and varieties of Celebes possess a striking character in the form of the anterior wings, different from that of the allied species and varieties of all the surrounding islands; 6, tailed species in India or the Indian Region become tailless as they spread eastward through the archipelago.

We are unable to enter into any of the numerous details given in illustration, but they furnish in the author's opinion "a strong corroborative testimony in favour of the doctrine of the origin of species by successive small variations." As to the causes which have led one group of butterflies to imitate another, the author agrees with Mr. Bates, that the object of mimicry "possesses some means of defence (probably in a peculiar odour or taste), which saves it from attack," and the imitating groups "thus gain an advantage in a freedom from persecution similar to that enjoyed by those they resemble." It would

certainly have been more satisfactory if we had been furnished with any evidence of these persecutions which are supposed to have led to such important results.* Notes are given of 123 species of Papilionidæ belonging to the Malayan Region, ranged under the genera *Ornithoptera*, 16 species; *Papilio*, 103 species; and *Leptocercus*, 4 species; but for these, and the remarks on their arrangement and geographical distribution, we must refer to the paper itself, which is illustrated by seven coloured plates. Unfortunately, however, the upper surface of the wing on one side and the lower on the other, are represented in each figure, and this gives an awkward appearance to the whole, and deprives them of all æsthetic value.

The difficulty as to what are species and what only varieties, receives an illustration from Mr. F. Smith's paper "On the Species and Varieties of the Honey-Bees belonging to the Genus Apis." ('Ann. and Mag. Nat. Hist.,' vol. xv. p. 372.) Mr. Smith had described twenty species; Dr. Gerstaecker, with the exception of two species, apparently accidentally overlooked, reduces these to four. In the paper above quoted, its author now limits them to eight. In the same volume of the 'Annals' (p. 182), is a translation of Professor Schiodte's paper "On the Classification of Cerambyces, with particular regard to the Danish Fauna." The author is patriotic enough to adopt the ordinal names of his countryman Fabricius, and he even finds it "necessary to return to that point to which Fabricius had carried our systematic knowledge, and to continue where he had left off." Many of his suggestions have been anticipated long ago, but the Professor is apparently not aware of Dr. Leconte's contributions to the American Scientific Journals, or of the still later works of M. James Thomson and others. A long account of the Chigoe (*Rhyncoprion*, or more correctly *Sarcopsylla penetrans*) is furnished by Karsten to the 'Bulletin de la Société de Naturalistes de Moscou.' It is only the fecundated females which are parasitic. They establish themselves under the skin, generally under the toe-tails, and soon attain an enormous size; when all the eggs are developed and deposited, the empty and shrivelled body is supposed to be thrown out, but whether the larvæ are developed in the ovary, or from the eggs after deposition, has not yet been ascertained.

A singular instance of parasitism has been recorded in the 'Entomologist's Monthly Magazine' (vol. i. p. 281). One of the white butterfles (*Pieris rapæ*), on emerging from the pupa, was found to have two little yellow cocoons of *Microgaster glomeratus*, containing pupæ, rolled up in the wings. The butterfly lived for some days, and excepting that the wings never attained their full size, was otherwise perfect. The ichneumon flies, however, it appears, were dead. The editor's explanation is this:—"It is well known that, as a rule, the

* At a meeting of the Entomological Society (May 2nd, 1864), when this subject was discussed, Mr. Bates said it was not an uncommon thing in this country to see the Pontiæ pursued by birds. Mr. Wallace admitted that he had not seen butterflies pursued to any great extent. Major Cox had seen forty or fifty individuals of a moth (*Brephos notha*) destroyed by tom-tits in a single morning. Dragon-flies were also suggested as being destructive of butterflies.

female *Microgaster* deposits a large number of eggs in one larva, and it is probable that a larva, once attacked, is freed from further molestation; the parasites knowing instinctively that the larva could only nourish a certain quantity to maturity. Possibly, therefore, the *Microgaster* attacking the above larva was disturbed after laying but very few eggs, and the produce of these was not sufficient to destroy the *Pieris* larva. If the parasites had not escaped previous to the transformation of their victim into the pupa state, they would naturally be unable to force their way through the hard pupa skin; and, as it seems, would form their cocoons inside, and be dragged out by the struggles of the butterfly to escape."

M. l'Abbé de Marseul has given descriptions of the *Histeridæ* collected by Mr. Wallace, in 'L'Abeille.' There are 101 species, of which 54 are new. Dr. A. Dohrn continues his descriptions of New Dermaptera in the 'Stettiner Entomologische Zeitung.' The fourth 'trimestre' of the French Entomological Society has not yet been received.

Entomological Society.

At the March meeting of the Society, Mr. M'Lachlan read a paper, entitled, "Trichoptera Britannica: a Monograph of the British species of Caddis-flies." 124 species are described, belonging to forty-three genera. Mr. Pascoe read a paper "On Generic Names having the same Sound," in which he strongly deprecated the practice recently adopted by some Continental naturalists, of changing generic names whenever they happened to differ but slightly from previous names. At the same meeting it was announced that the Council of the Society had determined to offer two prizes, of five guineas each, to the authors of the two best Essays or Memoirs on the anatomy, economy, or habits of any insect or group of insects which is in any way serviceable or obnoxious to mankind.

At the April meeting, Mr. Bates read a paper "On Agra," a genus of Carabidæ. The species are arboreal in their habits, and possess crepitating powers, the explosion not being audible, but capable of being distinctly felt, and leaving a stain upon the fingers. There were 140 species described, mostly by the Baron de Chaudoir; Mr. Bates now adds sixteen new species taken by himself in the Amazon region. Some very peculiar kinds of galls (if some of them were really the productions of insects) collected by Mr. Lowne in Syria, were exhibited by Mr. W. Wilson Saunders. An extract from a letter was read by Mr. Pascoe, in which the writer mentioned that the sounds emitted by a species of *Bolboceras* found burrowing in the hard roads at Gawler, South Australia, were caused by rubbing the tarsi against the coxæ. Some doubts were expressed as to the accuracy of the writer's observations.

At the meeting in May, the Reverend Hamlet Clark read "Descriptions of new Phytophaga from West Australia." Among them was a very abnormal form belonging to the family Eumolpidæ; it is a leaping insect, but the saltatorial power is given not by the pos-

terior legs, as is otherwise invariably the case, but by the intermediate, the femora of which are thick, robust, and tolerably elongate, with curved tibiæ. It was proposed to be described under the name of *Thaumastomerus viridis.* Mr. Bates read a paper "On a New Species of Agra, from the Collection of Mr. W. Wilson Saunders;" and Mr. F. Smith read "Descriptions of some Species of Hymenopterous Insects belonging to the families Thynnidæ, Masaridæ, and Apidæ."

In the last part of the Journal, at page 285, it was stated that the number of members of this Society was but ninety-seven. This, however, comprised those only who had paid their subscriptions for the year, not those who had compounded, or who were in arrears. The real number was, at the time, about 140.

VI. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

At one of the latest of the meetings of the Royal Geographical Society, an eminent authority on geographical, as well as other scientific matters, spoke with somewhat of nervous excitement, of what he considered the want of attention paid by the scientific men of England to a foreigner, then lying on a sick bed: he spoke of Lieutenant Maury. Within a few days after leaving this learned Society for the sick-bed of his friend, Admiral Fitzroy himself lay stretched upon the bed of death, stricken by a hand no longer guided by the light of that reason which has founded a new science amongst us; but moved by frenzy, of which the excitability of the former evening had been but the prelude, the flicker as it were of the summer lightning before the storm began. The over-taxed brain broke down amidst its work. That work has become a household word among us. In looking for Admiral Fitzroy's forecasts of the weather, we are apt to forget the earlier tributes which he paid to science. In two voyages in the 'Beagle,' in the latter of which he was accompanied by Mr. Darwin, he performed important work in surveying the southern hemisphere, and by describing what he had surveyed, he made permanent his discoveries. His researches on meteorology have placed that subject on the footing of a science, and whatever discoveries may hereafter be made in this direction, will have to be attributed to the excellent order and arrangement that he has introduced amongst the mass of already well-known facts, and to his patient abstinence from prejudging where the temptation must have been very great. Besides this, Admiral Fitzroy was at one time a member of Parliament, and afterwards Governor of New Zealand.

A younger and a less known man, Henry Christy, had just been recommended by the Council of the Royal Society to be honoured with the mystic letters F.R.S. after his name, but death forbad the investiture. Originally in business, he had devoted his later years to travel and scientific investigations, chiefly in reference to the early history of mankind as told to us in customs and in antiquities of savage nations. He ex-

plored that extremely interesting and little known country, Mexico, in company with Mr. Edward Tylor, the author of 'Anahuac,' a work of great research, and still later of a very thoughtful, carefully collected, and judicious book, entitled 'Researches into the Early History of Mankind.' These two works of his friend and companion indicate the line of research of Henry Christy, and in him the scientific world has to regret a patient collector and a learned thinker. Mr. Christy was no mere musty antiquarian; but his sympathy and his charity were warmly extended to many in their need—to the Irish during the famine, to the Danes during the war.

After our losses, let us reckon our prospective gains. Next in importance to the exploration of the neighbourhood of the North Pole, which we defer noticing until we come to the proceedings of the Geographical Society, ranks the proposal for the exploration of Palestine. This is certainly an association of things new and old, which ought to keep us in mind of our own ignorance, and make us a little humble as to our scientific acquirements. That the country most interesting to us, not only on religious grounds, but even on a mere historical basis,—for the history of the Jews is the oldest, and of old histories the best known of all,—that this land should be so little known to us that we cannot determine very many important localities; that we should know nothing, comparatively speaking, of its geological formation; and that the remains of its ancient races once hidden beneath the soil, have never been disturbed by the spade of the explorer, is extraordinary, to say the least of it, and if we can afford, for a time, to forget the disgrace which this entails upon us, it may be a most fortunate circumstance, since all that may be henceforth brought to light will be most carefully preserved, and accurate note will be taken of the position and accompaniments of each separate discovery. The survey of Jerusalem and of the level of the Dead Sea by the sappers under Captain Wilson, R.E., has suggested to a body of clergymen and laymen the propriety of forming a fund, similar to the Assyrian Exploration Fund, for extending this kind of survey and increasing its usefulness. There is much in the geology of the Holy Land, especially in the condition of the valley of the Jordan and the Dead Sea, that will excite the curiosity of the lovers of this science. The architecture of this country, perhaps, affords a wider scope than any in existence, since we have Jewish, Roman, Crusading, and Moslem modifications, all embraced within a small area, though extending over a vast period of time. Probably a not unimportant light may be thrown upon the origin of our own so-called Norman style, as originating from the influence of the Crusading and Moslem buildings upon one another. Again, the Holy sites have ever afforded a bone of contention for sects and topographers to wrangle over. Many of these must be, once for all, determined by a really careful survey, and the pretensions of such men as Dr. Priotti and Mr. James Fergusson will be estimated at their full value. The botany, zoology, and meteorology of this country all deserve attention, and though they have received some light from the labours of Tristram and others, and though a survey cannot be expected to effect much in

the short time which can be allotted to it, nevertheless its researches may afford a nucleus about which many now scattered facts may accumulate and add much to our very scanty information. The matter resolves itself into one of money. If the means are forthcoming much may be done, and that they will be so forthcoming the success of the Assyrian Excavation Fund gives good promise. It is to be hoped that if this expedition is sent forth upon a really substantial basis, its work will not be confined within too narrow geographical limits. The country east of the Sea of Tiberias, Jerash, and the neighbouring cities, as well as the more southerly districts of Moab, &c., are practically unknown, whilst Laborde's work on Arabia Petræa leaves much to be desired in that locality.

The two great volcanoes of Europe, Ætna and Vesuvius, have been for some time exhibiting signs of uneasiness. Whilst an eruption has actually taken place in the former, the latter has been reported to have its crater filled with seething lava, and to be capped by a suspicious fire and smoke. Earthquakes have been felt in Malta, Corfu, and other adjacent lands. But Ætna has afforded a magnificent spectacle. From seven mouths the molten mass of lava has been belched forth over hill and dale, and the whole neighbourhood has been terrified by the incessant noise, the lurid fires, and the destruction of cultivated land. Some of the sounds from the upper craters have been compared to the rapid blows of a smith upon his forge, and if the ancients ever heard such sounds, it is not to be wondered at that they invented the story of the Cyclops to account for these marvels. The French Government, who are never behindhand in any scientific investigation, have sent out a Commission, of which M. Fouqué is one, to determine the nature of the eruption. According to his report, the deep valleys and the sub-divisions of the streams have delayed the progress of the lava, so that no very extensive district has been destroyed. The vapours arising from the eruption have been divided by him into four classes: (1) the dry, containing salt, brooding over the incandescent lava; (2) the acid, with much water, in those places where the heat was above 400°; (3) the alkaline, where the thermometer stood between 100° and 400°; and (4) the carbonic, amid the lower temperatures. All these have been observed, classified, and tested. It is rather remarkable that but little sulphur has been perceptible; chlorine being on the other hand very common. Several photographs have been taken by M. Berthier, who accompanied the expedition for that purpose.

The interior of South America is about to be explored by Mr. Edward Bartlett, who intends to continue the researches in Natural History begun by Mr. Bates. The Brazilian authorities have received this gentleman with great civility, and have remitted in his case many of the vexations, as at the best of times they always will be, of the Custom-house. He reports that three lines of steamers now run up the river Amazons, dividing amongst themselves a distance of about 2,600 miles, beyond which again for nearly 500 miles navigation is open to large vessels.

We are again looking forward to an Atlantic Telegraph, executed

with more care and forethought than the previous unhappy failure. At the same time that this cable is about to be laid, a project for uniting the western coast of America with Asia is on foot; and, it is said, begun. From San Francisco the wires are to travel northward along the coast of British Columbia, traversing forest, fell, and river, until they have crossed the almost unknown districts of Russian America. Leaving Cape Prince of Wales, they will span Behring's Straits, where it is only thirty-six miles wide, and will again descend the eastern coast of Asia to the river Amoor. It is hoped to reach this point as soon as the telegraph from St. Petersburgh, and then we shall be in almost direct communication with British Columbia, and even California.

Central Africa, that exercising ground of incipient geographers, contributes but little to our chronicle this quarter. M. Eugène Jacques Marie de Pruyssenaeve died at Harab-al-dunia, near Khartum, on the 15th of December last, in his thirty-ninth year. Mr. Gerard Rolphs has started from Tripoli towards Timbuctoo, aided by supplies from Germany and our own Geographical Society. Dr. Mann, of Maritzburg, in Natal, has published the abstracts of six years' meteorological observations at the Observatory on that spot; according to these observations, the mean temperature nearly coincides with that of Adelaide in South Australia, a district some way further south, but having a hot and probably arid continent of land to the direct north of it, whereas Natal has land to the west only with a tendency of wind from the east. The amount of rain is greater than in London, though it falls upon fewer days in the year. Lightning was visible on 129 days in the year. The range of the thermometer is not extreme, being from 97·1° to 29°, or only 68·1° Fahrenheit. Of the 38·3 inches of rain that fell in 1864, the wettest year observed, 36·2 inches fell during the tropical showers of six wet months, leaving only 2·1 inches for the remainder of the year.

The captives in Abyssinia still remain in prison, and there seems little probability that either they or Captain Cameron, the British Consul, will be liberated except by death.

Towards the end of February last, the colony of Victoria was visited by a day of frightful heat and hot wind. The thermometer in many places stood very nearly at 100° in the shade; and in Sandhurst it even reached 105°. From the accounts we have received, we are unable to state whether the heat was the cause or the effect of enormous bush fires. The heat was accompanied by hot blasts of dense air, laden with smoke and dust, which almost prostrated the whole population. Fortunately, towards 5 o'clock P.M., the wind veered round to a mild south breeze, with slight rain; nevertheless the sky remained thick with smoke, and towards night it reflected with appalling grandeur the lurid glare of the distant bush fires. The destruction of crops and produce by the fires has been enormous, and can scarcely as yet be estimated.

Proceedings of the Royal Geographical Society.

An improvement in maps, being stereoscopic views taken from models of a country, is a subject worthy of the consideration of a Geographical Society, and as such was brought forward by Messrs. F. Galton and R. Cameron Galton. A model of a district, divided into squares and painted white, is photographed, and the resulting slide can be carried and used as easily as ordinary stereoscopic slides, whilst the information conveyed to the eye is of a different character and far more extensive, since the comparative height of all elevations can be seen at a glance. The mode of attaching names forms a source of difficulty, but this can be avoided by carrying another map. In any case it is a convenient mode of carrying what has all the advantages of a model with one on a journey.

"The Desiccation of Inner Southern Africa" formed the topic of a paper by Mr. James Fox Wilson. The aridity of the country has increased much within the memory of man, and a very great decrease of moisture is observable within certainly modern times. The *origin* of this parching up of a whole country was the only subject of discussion; of the fact there is no doubt. Dr. Livingstone considered that volcanic and geological changes were the principal causes, whilst Mr. Wilson is inclined to attribute a considerable portion of it to the felling of timber and other works of human influence. The matter is of some importance, inasmuch as in the one case we cannot help ourselves; but in the other, the interference of Government with the rapid clearing of districts might effect much towards modifying the evil, which is undoubted. The experience of Northern Africa might perhaps be useful in the South.

At the ninth and tenth meetings, a topic was again brought forward which had already been discussed, but which, nevertheless, still excites much interest, and is not likely to fall into oblivion until some practical result is arrived at. Since Sherard Osborn's first paper on the subject, an expedition to the North Pole has been urgently demanded, not only by geographers, but by men of science generally, as likely to throw light upon many highly interesting problems of climate, atmosphere, magnetic electricity, ethnology, and perhaps of archæology. The first document during this quarter on the subject, was a second letter from Dr. Petermann, of Berlin, who formerly accompanied an expedition to the Antarctic regions. This gave rise to considerable discussion. It was followed by papers "On the Climate of the North Pole," by Mr. W. E. Hickson; and "On the best Route for North Polar Exploration," by Mr. C. R. Markham. Dr. Petermann's object was to induce English geographers to adopt his plan of exploration by way of Spitzbergen, and the seas to the east of that island, in preference to the route by way of Smith's Sound and the west of Greenland. Steam vessels have never been tried in this direction, and the Doctor expresses confidence that a well-managed screw-steamer might easily penetrate the band of pack ice by which, he contends, the open sea at the Pole is surrounded.

The question, of course, turns principally on the probability of there being ice or land on the one hand, or water on the other, in the immediate vicinity of the Pole, a question which will probably be specially discussed in this Journal, and which we will, therefore, not touch upon here.

Spitzbergen affords many conveniences as a place to winter in, both on account of its accessibility and also because of the supplies of game that might be procured there. The route in this direction, too, is decidedly shorter than by Smith's Sound; but the main difficulty that can be foreseen is an impenetrable barrier of ice, after the pack ice and the open sea beyond it have been passed, a difficulty which is known to exist at the Antarctic Pole. The comparative merits of the two routes have been well discussed before the Society, and now the results have been placed before the Government, it only remains to await their decision.

Colonel Lewis Pelly, whose paper, "On the Islands of Kishm and Ormuz," we noticed in a former number, in a despatch to the Bombay Government, by whom it was communicated to the Society, stated that he was about to visit the capital of the Wahibite kingdom, in company with Lieutenant Dawes and Dr. Colvill. Colonel Pelly, in 1861, rode from Teheran to Calcutta in his uniform as a British officer, and the accomplishment of this difficult task was a fair earnest that he would fulfil his intention on the present occasion. The telegraphic announcement of his arrival at Bushire on his return has since been received.

A paper by Mr. Laurence Oliphant, "On the Bayanos river, Isthmus of Panama," draws attention to a spot where the two great oceans approach nearer to each other than elsewhere, but which spot, nevertheless, has been overlooked by surveyors. The distance to be traversed is only fifteen miles, but this has never been accomplished by a white man. The Indians have, as yet, stopped two travellers—Messrs. Wheelwright and Evan Hopkins—but they are said to drag their own canoes across from Chepo, the place visited by Mr. Oliphant, to the Mandingar river. The Columbian Government are endeavouring to make a road over the pass referred to in this paper.

The search for the seeds of the Pitayo cinchona plant for the Government of India, led Mr. Robert Cross from Chimborazo to Bagota, through the country of the Central Andes. The trees from which seeds could be obtained are fast dying out, but a good supply was obtained, which, it is hoped, will multiply in another part of the world. In passing the bleak plateau of Guanacas, Mr. Cross's mules had a narrow escape from perishing by cold, and the road was strewed with skeletons of men and beasts.

"The Specific Gravity, Temperature, and Currents of the Seas passed through between England and India," furnished Captain Toynbee with the materials of an interesting paper. The equatorial rains perceptibly affect the specific gravity of the water both of the Atlantic and also the Indian Oceans. The temperature showed the direction of the cold current which sweeps northward along the west

coast of Africa in July, and which curves sharply to the westward after crossing the line, in about 17° W. longitude. That this current comes from a southern origin is shown by the fact that it is at a higher temperature in March after an Antarctic summer. The southern ocean, too, sends icebergs into Table Bay, whilst the sea, only a short distance to the south-east, is at a much higher temperature.

"The Rovuma river, East Africa," described by Dr. Kirk, is interesting as being the point from which Dr. Livingstone intends to start on a new expedition into the interior. This stream is accessible to small vessels, in consequence of having no bar, and it leads inland just opposite to Lake Nyassa, from which the rapids that prohibit further navigation are distant not more than 100 miles. Dr. Livingstone intends to explore the whole of this lake, and, if possible, that of Tanganyika, and in this way to determine their connection and the line of the watershed of this region.

Dr. Gunst has visited several unexplored parts of North Madagascar, and found in the mountains tin ore, gold, traces of copper, and abundance of copal trees. He experienced some rough treatment from robbers, but was released by means of a vessel sent to his relief by the French Commander of St. Mary.

On the 22nd of May, the Anniversary Meeting of the Society was held at Burlington House, when the President delivered an address, and presented the medals, that of the founder to Captain Montgomery, R.E., for his trigonometrical survey from the plains of the Punjab to the Karakoram range; that of the patron to Mr. Samuel Baker, for his explorations of the interior of Africa entirely at his own cost.

Sir Roderick Murchison gave slight sketches of the lives of deceased Fellows,—the Duke of Northumberland, Captain Speke, and Admiral Fitzroy. He then touched upon the progress of geographical science. Australia has been explored over two-thirds of its surface, Cape York settled, Van Diemen's Gulf and the Northern Victoria river will probably soon be in the same condition; the coast has been surveyed, and a safe passage secured from Torres Straits to Queensland. It requires but little further exertion to secure constant communication with these colonies by way of the Singapore and the Eastern Islands. In our own possessions in America, especially in the great territory of the Hudson's Bay Company, much work remains to be done, and that such work is not altogether uninteresting is shown by the journey of a young nobleman and his companion across the Rocky Mountains to California. Central America has been again brought before us by Mr. Oliphant (to whose papers we have referred above). In Asia, the vast unvisited empire of China promises to afford means of testing the accuracy of our only predecessors, Marco Polo, Huc, and Gabet. The Korea, once under Japanese rule, and the extensive empire of Japan itself, also are likely to supply material for research for some considerable time to come. Dr. Livingstone's book, which is shortly to appear, will show

that much is still unexplored in the unknown regions of Southern Africa, even if Mr. Samuel Baker, who was last heard of at Ungoro, has been enabled to accomplish all that he wished and attempted, and notwithstanding the labours undergone by Mr. Charles Livingstone, Dr. Kirk, and the late young Thornton, each in his special line. In conclusion, the President informed the Society that he had communicated with the Grand Imperial Geographical Society of St. Petersburg on the subject of an expedition to the North Pole, and that, emboldened by their support, he had appealed to the First Lord of the Admiralty and to Her Majesty's Government, enumerating the advantages to science to be derived from a North Polar expedition, and transmitting copies of various supporting documents from other Societies.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Sciences bear to one another much the same relation as kingdoms and empires; and the connections of the latter by trade resemble, not very remotely, the aids which sciences give to each other. Thus geology has been assisted by several sciences, and has helped them in return; but it is generally considered that her "imports" have greatly exceeded her "exports." We are therefore glad to be able to adduce an important item towards producing a balance.

Geography and geology are naturally closely allied; to the one belongs the surface of the earth, to the other its substance. Of late years physical geography has been considered a separate science, forming the border-country between the two; and though it belongs more strictly to geography, it has necessarily been extensively invaded by geologists.

The physical features of mountains constitute an important subject of investigation to physical geographers, and the Alps have attracted their attention perhaps more than any other range. Until recently it was the custom to consider all great groups of mountains as forming "chains," but the irregularity of the Alpine so-called "chain" has long been a source of perplexity to its investigators. Geology has lately, however, suggested an explanation of this irregularity, and several Swiss geologists have come to the conclusion that the Alps do not form a "chain" of mountains at all; but that they consist of a number of central masses of crystalline rocks, flanked by valleys of slate, or other softer material. In other words, there is no great axis of upheaval; but the elevatory force was exerted at a number of points having no very evident linear connection, and separated by intervals of lower ground consisting of less crystalline rocks than the higher peaks

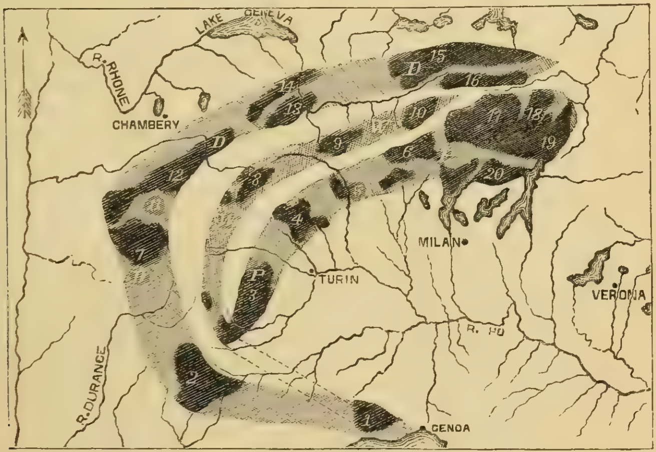
This theory has received its greatest development from M. Desor, in his work 'Der Gebirgsbau der Alpen,' just published. He describes

thirty-six "central masses," the first twenty of which are included in the annexed sketch-map. They are distinguished as follows :—

Central Masses of the

1. Ligurian Alps.
2. Maritime Alps.
3. Cottian Alps.
4. Graian Alps.
5. Sesia.
6. Monte Rosa.
7. Pelvoux, or Oisans.
8. Vannoise.
9. Valais.
10. Simplon.
11. Les Rousses.
12. Belledonne, or the Western Alps.
13. Mont Blanc.
14. Aiguilles Rouges.
15. Finsteraarhorn.
16. St. Gothard.
17. Tessin.
18. Adula.
19. Sureta.
20. Four Lakes.
21. Bernina.
22. Monte Adamello.
23. Selvretta.
24. Stelvio.
25. Oetzthal.
26. Ortles.
26 bis. Trentaises.
27. Tauern.
28. Ankogel.
29. Drau.
30. Carnian Alps.
31. Styrian Alps, or Hochgolling.
32. Gurk.
33. Carinthian Alps.
34. Bacherwald.
35. Sömmering.

Fig. 1.—*Sketch-map of a Portion of the Alps, showing the relationship of some of the principal "Central masses."*



M. Desor also shows that although there is no proper Alpine "chain," the "central masses" have yet a certain relation to one another, and he refers those shown in the map to three "groups," namely, the Dauphiny group (marked D), the Valais group (marked W), and the Piedmont group (marked P).

The following section along the St. Gothard route further elucidates the relations of the central masses, and shows that although they are often close together, so that in a broad sense some geographers may consider them to form a chain, yet that the fact of their not

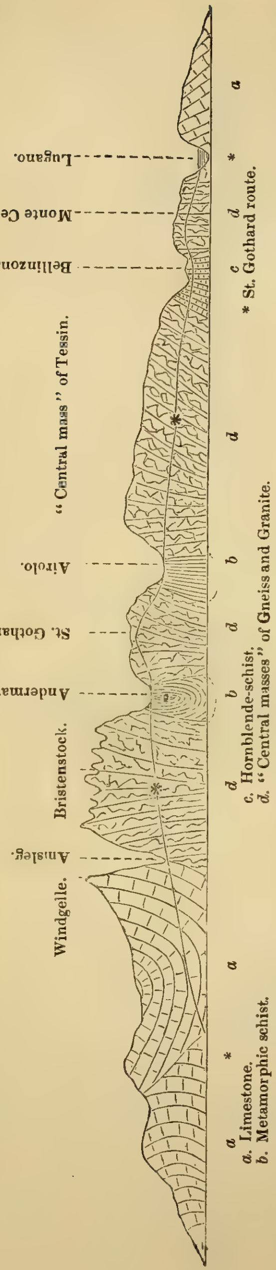


Fig. 2.—*Section across the St. Gothard Pass (after Desor).*

forming one continuous axis of upheaval, and their consisting of a series of independent masses of crystalline rocks, separated by low grounds formed of Triassic and more recent strata, show that the term "chain" is philosophically a misnomer, and that the Alps really consist of a group, or a number of groups, of more or less independent mountains.

But this is not the only question discussed in Professor Desor's work. The origin of lakes, the erratic and glacial phænomena of the Alps, and many other points of interest and importance in their physical geography and geology are investigated by him. We can only give a short *précis* of his views respecting the origin of the Swiss and Italian lakes.

The Alpine lakes he refers to two types, namely, the "orographical or mountain lakes," and the "excavated lakes." The former lie in the midst of mountains, and are one of the results of their elevation, while the latter are situated in the plain or on the borders of the mountains, and their basins have been excavated by *water*. The last conclusion, coming as it does from so eminent a Swiss geologist, is very important, especially as he considers also that the evidence is sufficient to prove that the lakes existed *before* the Glacial period. The Swiss lakes were for the most part "excavated by water," according to M. Desor, while the Italian lakes are situated in depressions between the mountains at right angles to their general direction. The Brianza-See belongs to yet another category, being a moraine-lake.

Another important contribution to Swiss geology has also reached us during the past quarter, namely, 'Geologische Beschreibung der

Nordoestlichen Gebirge von Graubünden,' by Professor G. Theobald. The author has good grounds for dilating, in his opening chapter, on the difficulty of geological surveying in this mountainous region, which is one of the most intricate and disturbed in Switzerland, and where the rocks are often masked by glaciers and fields of snow, while extraordinary contortions and even overturnings of the strata are so abundant as to become commonplace occurrences. Add to these difficulties that the rocks are often highly metamorphosed, so that different beds frequently look alike, while the same rock appears under a dozen different aspects, and that the fossils have generally been obliterated by the metamorphism, and we may then picture to ourselves the amount of patient and conscientious labour required of Professor Theobald during his survey of this district.

But this book, besides containing a complete geological description of the district to which it relates, includes a short essay on the physical features of the Alps, in which the author adopts the theory just explained, and describes in detail the central masses which he has examined. He observes that they consist of crystalline rocks, chiefly Gneiss, but sometimes Hornblende-schist and Mica-schist, while true granite is much less abundant than has hitherto been supposed. Around and between the central masses are zones of sedimentary strata, often metamorphosed into clay-slate, &c., the crystalline rocks having been thrust up from beneath them in anticlinal ridges, or more frequently in excessively contorted or reversed folds, not suddenly, nor by any grand convulsion, but slowly and silently. Professor Theobald truly remarks that the Alps cannot be understood geographically if their stratigraphical features be not taken into consideration.

Having thus indicated the chief features of this theory of the Alps, we must leave it to those particularly interested in the subject to read for themselves the descriptions of the different types of central-masses, and the numerous cases in which surface-form is shown to be dependent upon geological structure.

The last volume of the 'Bulletin de la Société Géologique de France,' contains an important paper by M. Levallois, entitled 'Les couches de jonction du Trias et du Lias dans la Lorraine et dans la Souabe,' &c. It may be considered the continuation of his paper on the 'Grès d'Hettange,' published in the previous volume. The author brings to the subject a larger share of philosophical coolness than French geologists usually possess, for he declares his belief that the boundary line of the Trias and Lias is destined to be the subject of eternal dispute.

The passage-beds, however, are shown by him to occur uninterruptedly and with a uniform constitution from the Ardennes to Morvan; they are composed chiefly of a sandstone which is the 'grès infra-liasique' of various authors, and which contains the fossils of the zone of *Avicula-contorta*. In the departments of the Meurthe and the Moselle and in Luxembourg they are constantly separated from the Hettange beds by an unfossiliferous band of red clay more than fifteen feet in thickness. He considers that the 'grès d'Hettange' is

not the representative of the 'grès *dit* infra-liasique,' and that while the fossils of the former are altogether Liassic in character, those of the latter are almost entirely Triassic; and, moreover, he states that there is less analogy between these two faunas than between the fauna of the Hettange beds and that of the zone of *Gryphœa arcuata* above them. In view of the facts he enumerates and the inferences to which they have led him, M. Levallois suggests that the term 'infra-liassic' should be abandoned, as far as concerns the zone of *Avicula-contorta*, and that the term 'supra-keuperian' should be used in its stead.

The geological results of the voyage round the world of the Austrian frigate 'Novara,' are being published with praiseworthy rapidity and in a remarkably liberal style. The 'First Part of the First Volume of the Geological Report' has just appeared, and it alone is a quarto volume of 274 pages, illustrated by six coloured maps, several chromo-lithograph views and sections, sixty-six woodcuts, and a beautifully executed photographed frontispiece, showing the glacier-district round Mount Cook, in the Southern Alps of New Zealand. The whole of this book is taken up with a description of the geology of New Zealand, the fossils having been described in several monographs, which have also been very recently published.*

The author of the "Geology" (Dr. Hochstetter) remarks that at present it is impossible to refer the strata of these islands to their exact European equivalents, but that he believes all the great formations known to us to be represented in them, from the oldest metamorphic rocks to the youngest sedimentary beds.

In the Southern (middle) Island, metamorphic rocks are extensively developed, and are evidently of great antiquity; then Dr. Haast has found fossils which he considers Silurian, in the slates of Mount Arthur (Nelson), and others in the Southern Alps, most probably Devonian. Next to these formations comes, in point of age, the oldest coal-formation, which contains plants corresponding with those of New South Wales, and is, therefore, most probably Palæozoic. The ages of the Secondary rocks admit of more exact determination, the fossils having been examined by European palæontologists in one of the parts of the "Palæontology" just enumerated. Their researches have proved the existence of the Trias near Nelson, one member of the formation (the Richmond sandstone) having yielded a variety of *Monotis salinaria* in immense numbers, *Halobia Lommeli*, Wissm., *Mytilus problematicus*, Zitt., *Spririgera Wreyi*, Suess, and other fossils of a less distinctive character. The occurrence of Jurassic rocks had before been stated by two or three observers, and Professor Owen four years ago described the remains of *Plesiosaurus australis* from beds near Waipara, inferred to belong to that period. Dr. Hochstetter gives now a number of most interesting details, especially

* 'Fossile Mollusken und Echinodermen aus Neu-Seeland.' By Dr. Zittel, Fr. Ritter von Hauer, and Professor Suess. 'Die Foraminiferen-Fauna des Tertiären Grünsandsteines der Orakei-Bay, bei Auckland.' By Herr F. Karrer. 'Fossile Bryozoen aus dem tertiären Grünsandsteine der Orakei Bay, bei Auckland.' By Dr. F. Stoliczka.

respecting the unconformity of the Tertiary to the Jurassic strata, the former being horizontal, while the latter dip at an angle of 35°.

Under the head of "Lower chalk" we find that Dr. Hochstetter classifies the beds containing *Belemnites Aucklandicus*, *Aucella plicata*, &c., at Waikato, Southhead, and those containing the same Belemnite, with *Ammonites Novo-Seelandicus*, and *Inoceramus Haasti* at Kawhia-Haven, although Dr. Zittel states, in the preface to the description of these fossils, that the evidence of the Belemnite and the *Aucella*, as well as of the *Placunopsis* occurring with the latter, is in favour of the beds being Jurassic, while that of the Ammonite and the *Inoceramus* indicates on the contrary their Cretaceous age. Certain coal-bearing beds, having a similar unconformable relation to the Tertiary deposits as the Jurassic strata just noticed, are thought by Dr. Hochstetter to represent either the Upper Jurassic or the Lower Cretaceous period, possibly the Wealden. They contain in the Northern Island a *Polypodium* and an *Asplenium*, and in the Southern Island (in beds probably of the same age) plants belonging to the genera *Neuropteris*, *Equisetites*, *Phœnicites*, *Zamites*, and *Pecopteris*, as well as a Dicotyledonous leaf.

The lowest member of the Tertiary system is a brown-coal formation; but it contains an entirely different flora, including two species of *Fagus*, one of *Myrtifolium*, five of *Phyllites*, &c., all of which, with the other plants, have recently been described by Professor Unger. The overlying marine beds are perhaps more familiar to English geologists than any of the deposits we have mentioned, in consequence of Mr. Walter Mantell's description of them having been published about fifteen years ago, under the auspices of his illustrious father, in the 'Quarterly Journal of the Geological Society.' They include an older and a younger series; the former is considered by Dr. Hochstetter to be probably contemporaneous with the Brown-coal formation, and to include the celebrated Ototara (or Oamaru) series, which the late Professor E. Forbes compared with the Bognor beds, but which Dr. Zittel thinks is much younger. The upper Tertiary deposits are doubtless very recent, but there seems some confusion as to the age of the older series; probably the beds in some localities may be much older than those in others, although now classified together through imperfect knowledge.

The Post-tertiary beds of New Zealand include Lignite-bearing strata, Glacier-drift, Marine and Fluviatile drift (including gold-drift), and all the superficial sub-aërial deposits usually found. But the most remarkable of the sub-aërial formations are undoubtedly the various results of volcanic energy exerted in different ways, and it would occupy the whole of this chronicle were we to attempt to give even an abstract of Dr. Hochstetter's description of them.

We have hitherto said nothing of the physical geography of New Zealand in relation to its geology. Dr. Hochstetter remarks that the three Islands belong geologically to one and the same mass, formed on both sides of a central axis, or axis of upheaval, ranging from N.E. to S.W.; but this is crossed at right angles by a line of depression in the direction of the straits which separate the islands,

having a strike from N.W. to S.E. nearly, and corresponding in direction with the line distinguished by Dana as the 'Axis of greatest depression of the Pacific Ocean.' He also says that the extraordinary variety of contour in the surface of the islands is explained by the diversity of their rock-formations, and that the change from mountainous to hilly, undulating, or flat country, from Alpine peaks to swampy flats and elevated plateaux, is always accompanied, or, more correctly, caused, by a corresponding alteration in the subsoil.

It is long since we have met with a work so thoroughly praiseworthy as this one, the more so as it is the result of a Government expedition, and is brought out at Government cost; but they manage these things better in Austria, if we may be allowed to apply the compliment to another country than that for which it was framed. We have given only the barest skeleton (not outline) of the contents of Dr. Hochstetter's book, and as for the several treatises on the Palæontology of New Zealand, though we should have liked to examine some of the points in regard to the distribution of species in ancient time suggested by their perusal, yet we have been obliged to refrain; for it is enough to have to digest at one sitting the characteristics of a new Jupiter, without being obliged to study those of all his satellites.

Proceedings of the Geological Society.

This quarter we have a very small instalment of the Society's Proceedings, the greater portion of the last number of the 'Quarterly Journal' being occupied by the Annual Report and the President's Anniversary Address.

The Address is prefaced as usual by the Wollaston Awards, mentioned in our last Chronicle, and the obituary notices of deceased Fellows, the list of whom contains many distinguished names, especially Mr. Leonard Horner, Dr. Hugh Falconer, Major-General Portlock, the Duke of Newcastle, the Earl of Ilchester (better known to geologists as the Hon. Mr. Strangways), Professor Hitchcock of Amherst, and Professor B. Silliman, founder of the 'American Journal of Science.'

The President (W. J. Hamilton, Esq.) in the Anniversary Address reviews at great length the chief geological discoveries and investigations made during the past year; but as our readers have already been made acquainted with their chief features, it will not be necessary for us to follow him in this discussion. We must, however, give a brief notice of his attack on the Glacier-excavation hypothesis, which has been so ardently advocated by his predecessor, Professor Ramsay.

Mr. Hamilton admits, of course, the enormously greater extension and thickness of the glaciers during the Glacial Period, and that their eroding power was consequently very much greater than that of their shrunken successors; but he does not believe that power to have ever been sufficient to excavate basins many hundred feet deep in solid rock, and he doubts "whether the position of these deep excavations

is such as any amount of glacial pressure could have produced under any circumstances." He distinctly separates the erosion of valleys from the excavation of lakes, as being two distinct questions, and his remarks apply only to the latter.

One President attempts to expose a logical fallacy in the arguments of the other, thus:—According to Mr. Hamilton, Professor Ramsay strives to show that neither a synclinal trough, a line of fracture, an area of subsidence, nor an area of aqueous erosion could have formed the sites of the Alpine lakes, because one is incompatible with existing conditions or phænomena in one case, another in a second, and so on, and that the action of ice is the only other cause by which the form of the ground could have been so modified; were this so, Mr. Hamilton would be quite right in saying, "it does not follow, for instance, that because the Lake of Geneva does not lie in a synclinal trough, it may not be in an area of depression, or that because the Lake of Garda is not in an area of depression, it may not be in a line of fracture." But, if we rightly understand Professor Ramsay, he is scarcely guilty of such an extraordinary piece of sophistry, for it seems to us that he endeavours to show that there is presumptive evidence against *any* of the lake-basins having been produced by *any* of the causes mentioned, the action of glaciers excepted. He does not take one cause for one lake, another cause for a second, &c., and then draw a general conclusion from particular premises. But this question has only a collateral bearing on that of the power of ice to excavate such rock-basins.

There seems to be much more force and justice in another of Mr. Hamilton's series of arguments. He combats the idea of a glacier being able to excavate a great rock-basin like that of the Lake of Geneva, after having emerged from a comparatively narrow gorge-like valley into a vast plain, where it must have reached a state of comparative, if not absolute rest; and he also urges that if the *vis à tergo* be what it is represented (of which, by the way, he seems very sceptical), and if it *did* force the ice into and along the plain, then the upper portion of the glacier would be forced over and along the lower, which would remain almost stationary. Professor Ramsay has stated that he "cannot conceive a horizontal fracture of forty miles in length over the area of the Lake of Geneva, clearly dividing two bodies of ice, the lower of which was when thickest nearly 1,000 feet, and the upper and sliding stratum must have been nearly 3,000 feet thick." Mr. Hamilton, however, states that the meaning is simply that the motion of the ice of a glacier resembles that of the water of a river, being fastest in the centre of the stream at the surface, with a gradual diminution towards the bottom and sides. This kind of motion seems entirely in accordance with natural laws, and quite fatal to the glacier-excavation theory.

Dr. Haast's papers contained in the same number of the 'Quarterly Journal' also relate to this subject; their titles are as follow:—

1. "On the Causes which have led to the Excavation of deep Lake-basins in hard Rocks in the Southern Alps of New Zealand."

2. "On a Sketch-map of the Province of Canterbury, New Zealand,

showing the Glaciation during the Pleistocene and Recent Periods as far as Explored, with an Appendix on the Climate of the Pleistocene Epoch in New Zealand."

Dr. Haast believes that New Zealand was submerged during the Pliocene period, and that, having been subsequently elevated, the chief physical feature of the country was a high mountain range, from which glaciers of enormous volume descended into the plain below, removing in their course the loose Tertiary strata, and thus widening and enlarging the pre-existing depressions, the occurrence of which had at first determined their course. So far most geologists will agree with him, in principle, at all events. But he further endeavours to show that after the glaciers had become to a certain extent stationary (meaning that their termination did not advance or retreat), moraines were formed, and rendered impermeable by glacier-mud; new moraine matter would then, he thinks, raise the bed of the outlet, and the water issuing from the glacier would consequently be forced up through its fissures, until it reached the level of the lowest portion of the moraine. Dr. Haast says that then the ice would be prevented by the moraine from advancing, and would expend its force in excavating a rock-basin near the termination of the glacier. This seems a very extraordinary process, and is singularly in contradiction to Mr. Jamieson's careful observations, which seem to prove that a confined glacier can ascend a slope of considerable steepness.

Dr. Haast's second paper does not seem to be of any great importance; but Dr. Hector's short memoir on the Geology of Otago, is a very valuable addition to our knowledge of the geological structure of New Zealand, especially as it refers to a Province not described in Dr. Hochstetter's work just noticed. This Province seems to have the following geological constitution:—The South-western part is composed of crystalline rocks forming lofty and rugged mountains, and intersected by deeply-cut valleys, which are occupied by arms of the sea on the west, and by great lakes on the east. These crystalline rocks comprise an ancient contorted gneiss, and a newer (probably not very old) series of hornblende slate, gneiss, quartzite, &c.; eastwards they are succeeded by various rocks of Mesozoic age; then follow the great auriferous schistose formations, which comprise an Upper, a Middle, and a Lower portion, and upon these occurs a series of Tertiary deposits, the lowest of which may, however, possibly be of Upper Mesozoic date, while the Upper, consisting of a fresh-water and a marine series, are unconformable to it, and are decidedly much more recent. It will thus be seen, that there are many points of similarity between this Province and those examined by Dr. Hochstetter; but that there are also important differences, notably, in the absence of all mention by Dr. Hector, of the occurrence in Otago of fossiliferous Jurassic and Cretaceous rocks; for the age of his "Mesozoic" rocks is merely inferred from their position and strategraphical relations.

This number of the 'Quarterly Journal' also contains a short but very important paper "On the Coal Measures of New South Wales," by Mr. W. Keene. The author is Examiner of Coal-fields and Keeper

of Mining Records for the Colonial Government, and has had, therefore, abundant opportunities of investigating the range of fossils through the different beds amongst which the coal occurs. He states that *Glossopteris* and *Vertebraria* (which Professor M'Coy considers to prove their Mesozoic age) occur from the top of the Coal-measures almost to the bottom; associated with these plants, in some of the lower beds, are *Pachydomus*, *Bellerophon*, *Spirifer*, *Fenestella*, and *Orthoceras*, while a Heterocercal fish occurs higher up, and *Lepidodendron* is found still lower down. The admixture of the Palæozoic fossils with the so-called "Mesozoic" plants appears clearly established; there is no doubt about the age of the former (in a broad sense), whereas the plants do not form a very safe guide, so that at present the Coal-formation of New South Wales must be looked upon as Palæozoic.

The Annual Report shows the Society to be in a remarkably flourishing condition, seventy-five Fellows having been elected during the year. Amongst the new Fellows we cannot help noticing the large number of Civil Engineers (including Mr. M'Clean, Pres. Inst. C.E.); and we are glad to observe the names of several Clergymen, amongst which that of the Rev. H. H. Winwood will be familiar to Members of the British Association. The list also includes the names of many local Geologists of good repute, especially Mr. W. W. Stoddart, the Rev. R. Boog Watson, Mr. H. B. Brady, Mr. George Maw, Dr. Rubidge of Port Elizabeth, and Dr. Atherstone of Graham's Town, while Mr. S. V. Wood, junior, has more than a local reputation. We hope that Geology and Science generally have found a new advocate in another new Fellow, Mr. Reginald Yorke, M.P. for Tewkesbury, and a new investigator in the Hon. A. Strutt, this year's Senior Wrangler.

VIII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The most remarkable event of the quarter has been the introduction, by Lord Kinnaird, of the "Metalliferous Mines Bill" to the House of Lords—and its withdrawal on the evening appointed for the second reading. It will be remembered, that Lord Kinnaird was the Chairman of the Commission appointed to inquire into the health and safety of the miners working in metal mines. The inquiry instituted by this Commission was an extensive one—and most laboriously have they worked. The result—which has been published in three thick blue books—is summed up in six resolutions, which were submitted, unanimously, by the eight Commissioners to "Her Majesty's most gracious consideration." These may be stated briefly to be—that metal miners die young, and that this is due to imperfect ventilation and to the exertion of climbing on ladders from great depths. That sufficient caution is not employed in the mines—that abandoned shafts are left unfenced and are "a cause of serious danger, not only to the miner, but to the public." The employment of boys underground at

too early an age—and the present system of mine-clubs are also submitted as great evils.*

Some causes, which have been hinted at,—but which are not sufficiently clear,—induced all the Commissioners, except Lord Kinnaird, to avoid proposing any legislative application, to remedy the evils which they had themselves pointed out. That nobleman, actuated by the most humane intentions, took upon himself the burthen of preparing a Bill, by which he hoped to remedy some of the existing evils. Lord Kinnaird desired to avoid the machinery of a large body of Inspectors, and he proposed the formation of a Board of practical men, who, with a few Inspectors at their command, might see that remedies were applied where they were thought to be necessary. At this idea of a Central Board, the miners, especially of Cornwall, took alarm, and a powerful opposition was organized. The influence of this has been, that—especially as the Government expressed their intention of opposing Lord Kinnaird's Bill, if it was pressed this Session—the framer has withdrawn it, expressing his intention to introduce an amended Bill, which will stand over for consideration early in the next Session.

It is by no means desirable that legislative interference should take the place of any existing desire to remedy acknowledged evils. It is stated that improvements have been gradually, and are being continuously, introduced into the system of working our metal mines. If this be so, then let us hope that evidence will be given of it so strongly between this and next year, as to remove every argument which may be brought forward for the introduction of another Metal Mines Bill. We regard all attempts to improve the working classes by legislative means as a blundering way of arriving at a desired end. Let the working man, and the employer equally, be taught, in the first place, to feel that their interests are identical—and then be instructed in those truths which improve the powers of observation, and enable them to see the existing evils, and apply the proper remedy. We may depend upon it, the individual effort will effect a much greater reform than will be possible with the best constituted Board.

Great interest attaches itself to the phenomena of the diffusion of gases, which appear to have been noticed in the first instance by Dr. Priestly,† and subsequently investigated by Dr. Dalton ‡ and by M. Berthollet.§ Döbereiner, in 1825, also made some remarkable observations, but for the full investigation of the subject we are indebted to Professor Graham.‖ It has been long known, that gases which do not enter into chemical combination will diffuse themselves through one another, though kept externally at perfect rest, and form a uniform mixture, though their specific gravities may be very different. Professor Graham, by the use of a very ingeniously-constructed instrument

* The whole question has been dealt with by Dr. Angus Smith, F.R.S., in two papers in the 'Quarterly Journal of Science,'—"On Metal Mining," No. v. p. 59; "On the Health of Metal Miners," No. vi. p. 216.

† 'Experiments and Observations on Different Kinds of Air.' Vol. iii. p. 29.

‡ 'Philosophical Magazine.' Vol. xxiv. p. 8.

§ 'Mém. d'Arcueul.' Vol. ii. p. 463.

‖ 'Elements of Chemistry.' Second edition. Vol. i. p. 87.

called a *diffusiometer*, has obtained an exact measurement of the rate at which this interchange takes place. He found that the diffusion of gases through porous septa is regulated by the same law as when they communicate freely with one another, *namely*, that *the relative diffusibilities are inversely as the square roots of the densities.*

A very beautiful application of the Diffusion of Gases has been recently patented by Mr. G. F. Ansell, of the Royal Mint. In our coal mines, there are not unfrequently, evolved from the coal beds, considerable quantities of light carburetted hydrogen gas. This gas mixing with atmospheric air, forms the explosive fire damp, from the ignition of which the most disastrous consequences too frequently ensue. Mr. Ansell's object has been to construct an instrument which should indicate the presence of this gas in any part of the coal mine—give warnings of its presence—and, indeed, measure the percentage quantity in which it exists relatively to atmospheric air. We have given drawings of some forms which Mr. Ansell's instruments have taken, and a description of those will sufficiently explain their action under the influence of the diffusing gas.

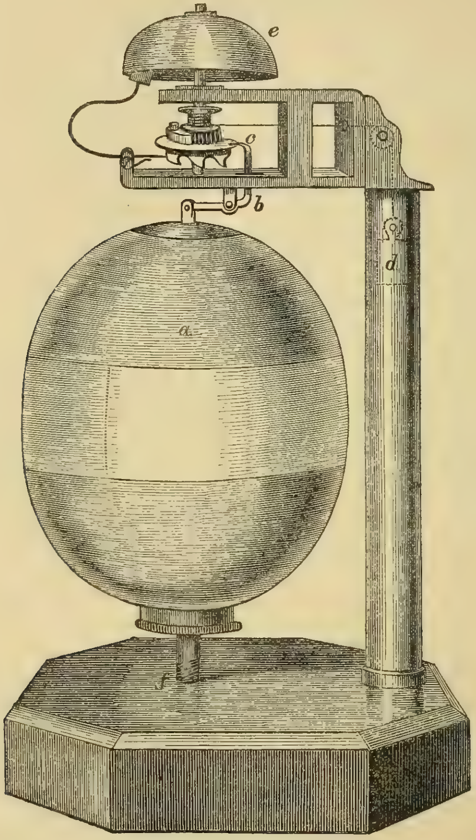
Carburetted hydrogen gas,—either *heavy*, as ordinary coal gas, or *light*, as marsh gas or coal-mine gas, though lighter than air,—diffuses itself readily through air. Upon this is founded the method for detecting its presence. Fig. 1*a* is a small balloon of india-rubber filled with atmospheric air, bound around the middle with a band of linen, to prevent lateral expansion. This is placed under the lever (*b*), resting on a stand at (*f*), where there is a screw to adjust the bag of air to a proper height. When adjusted, the balloon presses lightly upon the lever (*b*) already referred to. If this arrangement is placed in an atmosphere containing but a small percentage of carburetted hydrogen, this gas passes rapidly through the india-rubber by diffusion, and, of course, expands the balloon. In expanding this, the lever is raised ; and by the arrangement shown at (*c*), the rachet wheel is released, and the cord and weight (*d*) liberated, and in the fall of the latter down the pillar, a bell is rapidly and repeatedly rung. By the same form of apparatus, connection may be made, or broken, with a voltaic battery, or a magneto-electric machine put in motion, and a telegraphic signal given at the surface of the mine, either in the office or in any convenient place.

Fig. 2 is another form of the instrument. A cup of mercury is inclosed in a cell of porous earthenware, through the top of which a tube passes to the bottom of the mercury. On the surface of the mercury, in the tube, is a floating weight attached to a string, which is carried over a pulley, and, by its rise or fall, moves an index upon a dial, precisely in the same manner as in the ordinary wheel barometer. The gas, even when it exists in the smallest quantity, passes into the porous cell, and thus increasing the volume of the inclosed air, it presses the mercury up into the tube, lifting the float, and thus moving the index. This arrangement may be made to ring a bell, or to establish electro-telegraphic communication.

Fig. 3 is a glass U tube, holding a little mercury or coloured water. This is fixed upon a board, on which is a scale graduated by

experiment. Over one arm of the tube is fixed a porous plate. A superior material for the porous plate has been found in the artificially-compressed graphite of Mr. Brockeden. It is sold for making pencils

FIG. 1.



in small two-inch cubes. This is easily cut into slices by means of a steel spring saw, and by rubbing it on a piece of flat sandstone, it may be reduced to any degree of thinness. A circular disc of this substance, about the size of a wafer, is placed over one arm of the U tube. This is carried into the colliery, and the percentage of gas in the air is shown by the rise of the fluid in the open arm of the tube.

Fig. 4 is a section of a porous cell to be used with the apparatus shown in Fig. 3. Fig. 5 consists of (a) a porous tile secured into a glass vessel (b), which is connected with a U tube having some mercury in it. The arrangement is then made as in the former case, so that the index is moved the moment diffusion takes place.

Fig. 2.

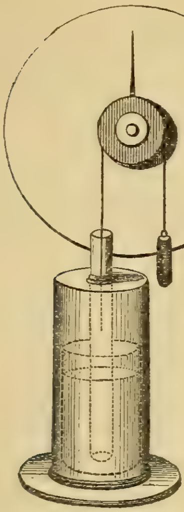


Fig. 3.

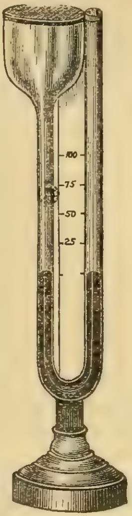


Fig. 4.

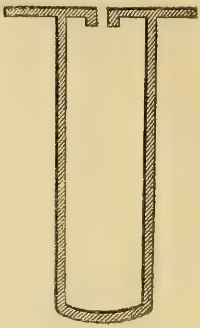
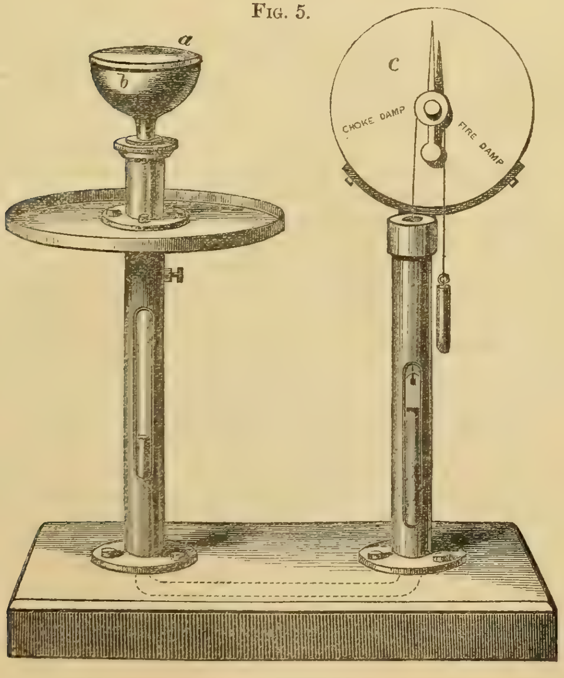


Fig. 5.



There are many other forms which might be given to this apparatus. Indeed, Mr. Ansell has nearly completed one of a most portable description, which is about the size of an old-fashioned watch. It can therefore be carried into the colliery by the viewer in his pocket, and employed at any moment to determine the amount of dangerous gas present in the air.

When the diffusion has been completed, that is, when the air within and without the porous septa has become of the same character, the index ceases to move. To restore the index to zero,—which is bringing it back to its normal state,—nothing more is necessary than to place it, for a few minutes, in atmospheric air which is free from carburetted hydrogen.

We have rarely seen a more refined application of science than this, and we cannot but believe it will be found of great practical utility as indicating the presence of fire-damp in collieries, before it becomes dangerous from accumulation.

In our second Number (April, 1864), we directed the attention to the production of gold from the Quartz veins of the rocks near Dolgelley.

It appears that at Vigra and Clogau, above 1,600 tons of auriferous quartz have been operated on during 1864, and from that quantity upwards of 11,000 ounces of gold have been obtained.

The quantities of gold produced in the whole district during last year were as follows:—

	Gold Quartz.		Gold.		Value.
Vigra and Clogau	1,679 tons,	yielding	2,331	ounces,	£8,434
Cefn Coch (Welsh Gold Mining Com.)	604	„	346	„	970
Castell carn Dochan . . .	29	„	141	„	394
Hafod-y-Morfa, Prince of Wales' Mine .	20	„	63	„	176
Gwynfynydd	$4\frac{1}{2}$	„	6	„	17

Some very interesting and important experiments are now in progress for the purpose of testing, on a large scale, a discovery which has been recently made by Mr. William Crookes, F.R.S., in connection with the process of amalgamation by which the gold is separated from the other matters with which it is mixed. For a long period, the "sickening" of the mercury, as it is technically called by workmen, has been a source of much annoyance and loss. When sulphur ores, arsenic, bismuth, or tellurium are present, the fluidity of the mercury is destroyed, and it becomes either a tenacious mass or it assumes a powdery character; in either case, becoming useless.

Mr. W. Crookes has entirely removed this difficulty by combining a little sodium with the mercury. This preserves the fluidity of the mercury under all circumstances, and, of course, its amalgamating powers. Not merely this, but the sodium amalgam is a preservative against the injurious action of grease in the process. As we have said, extensive experiments are now in progress. Nothing can be more satisfactory than this process appears to be; but the whole subject is so full of interest, that we prefer waiting until we are furnished with a detailed statement of the results,—which we are promised,—when we hope to devote an article to the consideration of

the gold rocks of North Wales, and the processes which have been used, at home and abroad, for the separation of the gold.

The following statement has been handed to us. It shows the total quantity of gold obtained from the neighbourhood of Dolgelley up to the end of 1864 :—

	Oz.	Dwts.	Grs.
Old Dolfrwynog	117	5	5
Prince of Wales	63	0	0
Cwmheisian	176	0	0
Gwynfynydd	6	2	3
Welsh Gold Company	478	17	23
Castell Carn Dochan	183	15	3
Vigra and Clogau	10,778	0	0
Total	11,802	0	10

Mineralogy.

M. Haidinger* has called attention to some very curious stalactites of green carbonate of copper found in a mine which has been long abandoned at Reichenau, in Austria. The mine had been originally worked for carbonate of iron, and iron and copper pyrites. These stalactites had resulted from the decomposition of the pyritic ores. M. Haidinger supposes that the carbonate of copper had been precipitated in a pulverulent state, carried forward by water, and slowly consolidated under the influence of crystallization. Many of these crystals present a rough and black surface, which appears to be black oxide of copper. A series of curious metamorphoses have evidently been going on between the formation of sulphate of copper, by the decomposition of the sulphides of iron and copper, and the formation of the carbonates and black oxides.

A mountain of iron, rivalling, says the Abbé Moigno, "celles si fameuses de Marquette," has been discovered upon the borders of Lake Superior. A certain quantity of this iron ore taken from a depth of about sixteen feet from the surface, and smelted in an ordinary furnace, has given 60 per cent of iron, which is nearly equal to our finest red hæmatites.†

M. Kuhlmann is continuing his important inquiry on crystallogenic force. He has recently communicated to the Academy the fourth part of his memoir on this subject. It is not possible to present an abstract which would convey any satisfactory idea of the principles involved in the consideration of this subject. We must refer our readers to the original memoir.‡

M. Henri St. Claire Deville has communicated to the Academy of Sciences two notes by M. Felix Pisani. The first is on *Kalicine*, a new mineral species from Chypis, in Valais; and the second on the *Pisolitic Limonite*, of Iwaro, upon the Lake Œdenburg, in Hungary.

Kalicine was discovered in the fine collection of M. Adams, under the name of carbonate of potash, and proved by analysis to be identical

* Institut Impérial de Géologie, Séance du 20 Décembre, 1864.

† 'Les Mondes,' 12 livraisons, p. 502.

‡ See 'Comptes Rendus' and 'L'Institut,' May 17, 1865.

in composition with the bicarbonate of the laboratory. This mineral has been met with at Chypis—under a dead tree—an aggregated mass of infinitely small crystals, translucid, and of a yellow colour. Analysis gives potassa 46·6; carbonic acid, 42·2; carbonate of lime, 2·5; carbonate of magnesia, 1·35; sand and organic matters, 3·60; water, 7·76. This composition corresponds to the formula $K C^2 + A_9$. It is the first example of carbonate of potassa being found in nature; and, it is evidently, of recent formation.

The Limonite of Iwaro is attributed to meteoric origin, and the date assigned to its fall is the 10th August, 1841. An analysis made by Redtenbacher proves that it is formed of sand—oxide of iron and oxide of manganese, with a little carbonate of lime and alumina. M. Pisani conceiving that, if of meteoric origin, this *Pisolitic Limonite* should contain nickel, and cobalt, has made a new analysis, which gives:—

Argillaceous Sand	58·9
Oxide of Iron	11·0
Oxide of Manganese	10·1
Oxide of Cobalt and Nickel	0·85
Alumina	3·7
Lime	1·45
Magnesia	0·72
Water	13·06

At a recent meeting of the Académie des Sciences de Vienne, a memoir, by M. de Zepharovich, was read—"On the Crystallization of Anglesite" (sulphate of lead). The examples obtained by M. de Zepharovich were from the lead mines of Schwarzenbach and Miss, in Carinthia. This memoir may be regarded as a companion one to the work of M. V. de Lang, upon the crystals of the same species of mineral of Bleiberg.*

The crystals obtained at Schwarzenbach are remarkable for their limpidity, and for the great number of their planes, appertaining to seventeen different crystallographic forms. Three of these forms were new—two pyramids, and one "un *doma*" or horizontal prism.

The two first forms are found equally frequent upon the crystals from Miss, which, in other respects, are of a totally different type from those of the crystals of Schwarzenbach. In both these localities the Anglesite is found upon the Galena—more or less decomposed—associated with oxide of iron; and at Miss the crystals of cerussite (carbonate of lead) are evidently of two different epochs of formation.

Mr. N. Story Maskelyne has communicated to the Royal Society a paper "On New Cornish Minerals of the Brochantite Group." These minerals have been already noticed in our Journal.

Professor A. H. Church has communicated a paper on the same subject, entitled "On some Hydrated Cupric Oxychlorides from Cornwall" and another "On some Hydrated Cupric Oxysulphates," to the Chemical Society.†

The mineral Phosphorite, which was stated to occur in large

* 'Comptes Rendus Académiques' de 1859.

† 'Journal of the Chemical Society,' March, 1865.

quantities in the district of Estramadura, in the South of Spain, has been recently analyzed by Dr. Forbes, F.R.S. The specimens received, though in large blocks, consisted of pure phosphorite, apparently unaccompanied by any other minerals; the mineral itself was massive, and, on breaking, the fracture was uneven and earthy, disclosing a slightly radiating dendritic structure, but no trace whatever of crystallization. The colour of fresh fracture was chalk-white, but weathered surfaces frequently showed a dirty or rusty white colour externally. Lustre earthy; opaque; streak and powder dead white. Hardness about 4·5. The specific gravity was taken on two distinct specimens, and found to be 3·00 and 2·92 respectively at 60° Fahr. The result of a very careful analysis gave the following composition:—

Fluoride of Calcium	8·01
Chloride of Calcium	0·16
Lime	41·03
Magnesia	0·12
Alumina	1·75
Sesquioxide of Iron	1·19
Phosphoric Acid	44·12
Sulphuric Acid	trace.
Carbonic Acid	0·40
Insoluble matter	1·41
Water	1·44
Total	99·63

Metallurgy.

M. Pastera, Chemist of the Department of Mines and Works, has been experimenting at Vienna on some new processes for the extraction of the gold disseminated in argentiferous minerals. Each metal is extracted separately—the gold by chlorine water, and the silver by a solution of salt, or by hot water after the silver has been converted into a sulphate by a roasting process. M. Pastera, after having made his first experiments on a small scale, proceeded to treat the roasted ores from Nagyag, in Transylvania, and he obtained the most complete success.*

Attention has again been drawn to the question, whether the molecular condition of metals, especially iron and steel, alters by continued vibrations or repeated percussion.

At a recent discussion on the Submarine Atlantic Cable, the liability to this alteration was insisted on as though it were a proved fact,† and in an established periodical,‡ it is implied that Mr. Sorby's microscopic researches have established the fact. It should be clearly understood by all, that there are not any experiments which confirm this statement, although there are many which at first appear to prove its correctness. Mr. Brunel showed that the same piece of good iron might be broken with either a fibrous or a crystalline struc-

* Institut Impérial de Géologie, Vienna.
† 'Phil. Mag.,' May, p. 340.
‡ 'Society of Arts Journal,' May 12, 1865.

ture. The first condition requiring dull and heavy blows—the second demanding sharp and violent ones. It is most probable that vibratory action of any kind, long continued, is liable to change the structure of metals; at the same time none of the experiments which have been made appear to have been sufficiently conclusive, and all the results obtained can be explained, as Brunel explained them, by the nature of the breaking blow. Seeing the important uses to which iron and steel are applied, it is surely desirable to determine this problem beyond all doubt.

We are desirous of recording every step, which may ever promise to be an advance in any of our Metallurgical operations. The Messrs. Woodwards, of Ancoats, have been making experiments on the smelting of pig-iron in the ordinary cupola, through the agency of steam. The great object being to get rid of the fan and its mechanical accessories. As we understand the arrangements, it appears to be the use, in a modified form, of the steam jet, as used by Goldsworthy Gurney, for ventilation, and as employed in our locomotive engines. At the upper part of the cupola, immediately above the part where the charge is put in, a steam pipe $1\frac{1}{4}$ inch bore is inserted into a wrought-iron chimney equal in length to the depth of the cupola below. Such is the arrangement. The fire is lighted, and the charge made in the usual manner. The door of the charging hole is then closed, and the steam is turned on. The rapid current of steam rushing through the chimney carries the air with it, causing a momentary partial vacuum immediately above the fuel and the metal. The only place through which air can enter is below—and there through ten openings it rushes in with a velocity which is regulated by the force of the steam jet. This arrangement is said to secure a general and uniform heat throughout the furnace, and to produce more perfect combustions of the fuel. For smelting a ton of pig-iron it is stated that little more than 1 cwt. of coke is required, while the bringing down of the molten metal is effected more speedily.

A further improvement in this apparatus is in progress. The upper portion of the cupola will be surrounded by a boiler, from which steam will be supplied to the fire. Thus, after the furnace has fairly started, it will, by its own heat, generate the steam by which the work is to be performed.

Some time since, our newspapers informed us that a wonderful iron letter was sent to this country from Pittsburgh. This was a sheet of iron so thin, that it required 1,000 of such sheets to make one inch in thickness, the dimensions being 8 inches by $5\frac{1}{2}$ inches, or a surface of 44 inches, and weighing 69 grains. Soon after, there was produced, at the Marshfield Iron Works, Llanelly, a sheet of the same size which weighed only 48 grains. This was soon followed by a sheet of iron, made at the Hope Works, in Staffordshire, with a surface of 118 inches, which weighed but 89 grains. This, reduced to the American standard of 44 inches, gives about 33 grains. While Messrs. R. Williams and Company made a similar sheet weighing but 31 grains, the Marshfield Company, desiring not to be outdone, soon succeeded in making a sheet of 44 inches, which weighed only $23\frac{1}{2}$

grains, and required no less than 2,853 sheets to make one inch in thickness; and eventually they made another sheet of 48 surface inches, which weighed 25 grains, and required 2,950 sheets to make one inch in thickness. At the Pontardawe Tin Works there was subsequently made a sheet having a surface of 115·17 inches, weighing 60 grains. This was a trifle heavier than the Marshfield sheet, but Pontardawe claims 3,799 sheets to make a thickness of one inch.

All this has, however, been outdone at the Upper Forest Tin Works, near Swansea, of Messrs. W. Hallam and Company. At their mills, a sheet of iron has been produced with 55 inches surface, and weighing but 20 grains, which, being brought to the standard of 44 inches, is but 16 grains, or 30 per cent. less than any previous effort, requiring at least 4,800 sheets to make one inch in thickness.*

Steel made at the Ebbw Vale works, by Mr. Parry's patent, has been rolled into exquisitely thin plates. The thinnest is said to have been ·001 in thickness, perfectly tough, smooth, and free from holes.

The Royal Academy of Sciences of Belgium has given its gold medal to Captain Caron, as the author of the best work on the constitution of steel. M. Straas, who was chairman of the committee appointed to examine the essays sent in, makes high commendation of Captain Caron's work. He expresses his entire concurrence in his opinion, that iron, in passing into steel, does not take up any nitrogen in addition to that which it already contained. Steel, M. Straas remarks, is essentially composed of iron and carbon, and owes its qualities or its defects to two different causes—the state of carbon in the metal, or the nature of the foreign bodies which debase it. Whenever steel is good, its carbon can, under the influence of tempering, combine with the metal, and give us a hard, brittle metal, which further tempering renders supple and elastic. When steel becomes hard after undergoing several heatings, it is due to its carbon having been burnt or separated from the iron, and tempering will not then regenerate the combination. This separation is due to the presence of foreign bodies, more especially silicium. M. Straas concludes by saying, "Captain Caron's Essay is undoubtedly the *résumé* of long and glorious labours, put forth with a simplicity and lucidity which greately enhance their merits." There will be many a dissentient voice in this country to the somewhat dogmatic statements of M. Straas.

PHYSICS.

Light.—Spectrum-analysis has recently performed a somewhat important service to chemistry. Besides the well-known chemical elements, and those new ones, such as Cæsium, Rubidium, Thallium, and Indium, which have after a long or short probation been definitely admitted into the family of elementary bodies, there are several substances waiting, as it were, on the threshold admitted as elements by

* Most of these particulars have been obtained from the 'Mining Journal.' The remarks on steel plates are from 'The Engineer.'

some chemists, but branded as compounds by others. In most cases not sufficient was known about them to enable the most impartial judge to decide one way or another. Amongst these two bodies, Erbium and Terbium, have long been kept in the same undecided state, and there is no knowing how many years more the verdict "not proven" might have been recorded against them had not spectrum-analysis come to their aid and substantiated their right to enter the family of elements. M. Bahr first discovered the absorption spectra of Erbium and Terbium, and they have since been submitted to a more extended investigation by M. Marc De la Fontaine. These bodies appear to be intimately associated with the element Didymium, the spectrum of which was discovered by Dr. Gladstone. A very dilute solution of nitrate of didymium shows three rather indistinct black rays, shown in Fig. 3 by the letters *a*, *b*, *c*. In strong solution other lines appear, and the complete spectrum is shown in Fig. 3. On examining a strong solution, a salt of Erbium gives a spectrum having eight bands of absorption, as shown in Fig. 1, and five when in weaker solution. Terbium when in solution gives only the rays shown in Fig. 2, and no more make their appearance, however concentrated the liquid is made.

The positions in respect to the coloured rays of the spectrum may be obtained by reference to the graduated scale, on which the red Lithium line = 10, the yellow Sodium line = 27, and the green Thallium line = 43.

As will be seen, two bands are common to the three elements, *viz.* Di_b, Tr_b, Er_a, and Di_c, Tr_c, Er_c, whilst Er_f is identical with Di_h.

In a former note we mentioned that Father Secchi had investigated the so-called *telluric rays* in the solar spectrum, and had arrived at the conclusion that they were due to the absorptive action of aqueous vapour. From a recent communication to the French Academy of Sciences we learn that the Reverend Father has repeated his observations with a more perfect spectroscope, and has been enabled to confirm his former results.

Dr. Gladstone, F.R.S., in conjunction with the Rev. T. P. Dale, M.A., has been for some time past investigating the Specific Refractive Energies of the Elements and their Compounds.

In 1863 they communicated a paper on this subject to the Royal Society and at the meeting of the Chemical Society, in May last, some further results of their joint labours were brought forward. The "specific refractive energy" of a body is a constant, and not affected by temperature, and is arrived at by dividing the refractive index of the substance (μ) minus 1, by the density. The formula already proposed was found to hold good on a more extended investigation of the subject, and the authors generally worked with the fixed line A. The proposition resolved itself into a study of the inquiry whether the specific refractive energy of an element was invariable under all circumstances of isolation or combination, and whether this property in the case of a compound was correctly expressed by taking the mean of the refractive energies of its several elementary constituents. As a

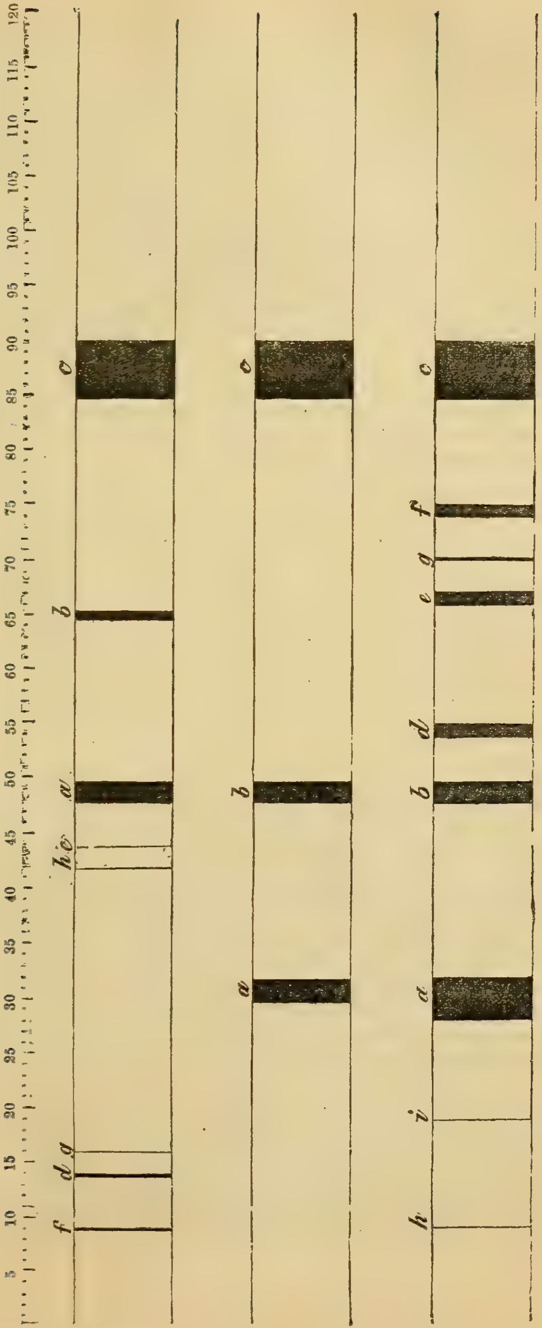


Fig. 1.—Erbium. Fig. 2.—Terbium. Fig. 3.—Didymium.

general rule this was found to be the case, but the authors brought forward a few exceptional instances which at present appeared to stand in opposition to their statement. Dr. Gladstone particularly referred to sulphurous acid, hydrated sulphuric acid, and aqueous tartaric acid, as presenting anomalies which were considered worthy of more extended investigation, with the view of determining the nature of the disturbing causes. This mode of physical research is interesting in connection with the study of isomerism, and will probably lend valuable aid in determining the internal constitution of bodies; thus, whilst aniline and its isomer, picoline, gave widely different results under this optical treatment, it had been found by Landolt that a mixture of equal equivalents of methylic alchol and acetic acid behaved precisely like its theoretical conjugate, glycerin. Dr. Gladstone exhibited in a tabulated form the numbers representing the specific refractive energies of many of the elements, multiplied by their atomic weights, or "refraction equivalents," as Landolt terms it, and he worked several examples by way of showing the application of the formula, and the mode of deducing from compound bodies the value of each constituent. The table stood thus:—

Name of element.	Refraction equivalent.
Carbon	5·1
Hydrogen	1·5
Oxygen	3·0
Nitrogen	3·3
Chlorine	8·5
Bromine	15.7
Iodine	24.4
Sulphur	16·0
Phosphorus	18·6
Tin	22·0
Sodium	6·0
Mercury	11·0

With regard to the value of carbon it was shown that the number observed in the case of the diamond agreed with the results deduced from the examination of carbonic oxide, carbonic acid, olefiant gas, and a variety of liquid hydrocarbons. Hydrogen did not appear to have precisely the same value in the form of gas that it had in certain hydrogen compounds, and the author stated that 7·6 was the average expression, from a great number of experiments, of the value of CH_2, the oft-quoted increment of carbon and hydrogen in the homologous series. Nitrogen in the form of gas was 3·3 as above, but in combination its value sometimes amounted to 4·2. In a similar manner the numbers representing oxygen and chlorine gases became subject to modification when those elements were combined.

Some novel experiments have been lately described before the Chemical Society of Paris, by M. Jodin, illustrating the action of light on vegetable matter. The author destroys the vitality of green leaves by immersing them in alcohol, or heating them to a high temperature in sealed tubes, and finds that after this the leaves still present some signs of life. In the light they are rapidly decolorized,

but excluded from air and light they preserve their greenness for an indefinite time. In the course ofthe decoloration by solar light, he proves that oxygen was absorbed and carbonic acid evolved. Under the same circumstances he finds the yellow matter in etiolated leaves to absorb oxygen. On the contrary, it is proved that etiolated leaves, in becoming green in the light, evolve oxygen, while those kept in the dark and unchanged in colour absorb oxygen. The author is disposed to regard chlorophyll as a body quite distinct from the yellow colouring matter of leaves.

The magnesium light promises to be of important use for lecturers and physical experimentalists. M. Lallemand, of Versailles, has found that it is sufficiently active to determine the combination of hydrogen and chlorine. The explosion may be effected with the light of a single wire burnt in a spirit lamp.

Whilst referring to the explosion of hydrogen and chlorine it may be of interest to many of our readers if we give in detail the mode of preparing the sealed bulbs containing exactly equal volumes of chlorine and hydrogen gases, which have been employed by Dr. Roscoe for exhibiting the chemical combination of these gases effected by the action of light. The process was fully described by Dr. Roscoe himself at one of the recent meetings of the Manchester Literary and Philosophical Society. The apparatus needed consists of a stout tube or narrow bottle of about 120 cubic centimetres capacity, fitted with a caoutchouc stopper with three holes bored through it. Into one of these holes a vent gas delivery tube passes, on to which three small wash bulbs are blown; into the other two holes are inserted the rounded ends of two lengths of the gas carbon, commonly used as terminals for the electric lamp; these poles are of such a length that they pass to the bottom of the glass bottle. This is then filled with strong aqueous hydrochloric acid, containing about 30 per cent. of the anhydrous acid; the stopper in the poles and wash bulbs containing a few drops of water is then fixed into its position, and the evolution vessel placed in a beaker of cold water, whilst contact is made with the terminals of four ordinary-sized Bunsen's cells, the whole apparatus being placed in a dark room. The mixed gases at once begin to be given off, and ought to pass through the wash bulbs at the rate of about two bubbles per second. It is absolutely necessary that the gas be allowed to come off at this rate for three hours before it is collected, as up to this time it does not attain a sufficient degree of purity and sensitiveness, whilst after the lapse of this time it is generally found to be fit for use. In order to absorb the excess of chlorine, the waste gas may be led into a condenser containing slacked lime and charcoal in alternate layers. When the evolution has gone on for the above-mentioned time, a bulb tube, connected by caoutchouc joinings, is placed between the evolution vessel and the condenser, and the gas allowed to pass through. The bulbs, which are made of fusible glass tubing, are blown about the size of a hen's egg, and so thin that they easily break when pressed with the finger. At each side of the bulb the tube is drawn out so as to be very thin

in the glass, and to leave the internal diameter not less than 1 mm., whilst at the extremities the tube is wider, so as to fit ordinary joinings. When the gas has passed through the tube for about ten minutes, the joinings are loosened and each end stopped with a piece of glass rod. The bulb tube thus closed is then removed from the evoluting vessel, and the thinnest part of the tube brought some little distance above a very small Bunsen's flame; the glass then softens below a red-heat, and the ends may be drawn out and sealed with safety. It is advisable to number the bulbs, and to test the first and last by exposing them to a strong light. Frequently, in spite of every precaution, the gas explodes during the act of sealing, so that in this operation it is advisable to hold the bulb with a cloth rather than in the open hand. As soon as one bulb-tube is removed, another is placed in connection with the evolution flask, and, after ten minutes, sealed as described. The above quantity of acid will serve for the production of sixty bulbs. Thus prepared, the sealed bulbs may be kept in the dark for any length of time without injury; some, which were known to have been made more than a year, were found to be perfectly good. To explode these bulbs it is only necessary to expose them to diffuse daylight or sunlight, when the combination occurs instantly. Of artificial lights, the bright flash produced by the combustion of the vapour of bisulphide of carbon in nitric oxide is most effective; but the light of burning magnesium wire, of phosphorus in oxygen, or the electric light, answers perfectly well. Professor Roscoe stated that Mr. Dancer, of Cross Street, had undertaken to supply the bulbs to persons unable to prepare them.

At the April Meeting of the same Society, Mr Dancer brought forward some curious experiments in pseudoscopic vision through prisms. If we look with both eyes at an object, such as the flat top of a table, for example, and then interpose a prism between one eye and the object, we discover, after a short time, that the portion of the surface to which the sight is particularly directed has apparently changed its distance. If, in trying the experiment, the thin edge of the prism is turned inwards to the nose, the flat surface will appear concave; if, on the contrary, the base or thick edge is turned towards the nose, the surface will appear convex. The full effect of this alteration in the appearance of the object is not realized immediately, some persons see it perfectly in a few seconds, others require some moments of steady gazing before it becomes evident to them. The character of the surface to which the vision is directed exercises some influence in producing the effect. A circular table covered with a cloth of a bright pattern, having a few articles disposed towards the edges, exhibits this fallacious vision in a marked degree. The angle of the prisms for showing these experiments should be about 15°; if less than this, the elevation or depression of surface is not sufficient to produce a good effect; if the angle is much greater than 15°, many persons are unable to unite the refracted image of the prisms with the real image seen by the other eye. Achromatic prisms are much to be preferred in these experiments to those which are uncorrected for

colour. Experiments with these prisms have shown that the power of converging the optic axes differs very considerably in individuals. The pseudoscopic effects are exaggerated by using a prism to each eye, but in most persons this produces a painful sensation. The explanation of these phenomena, which Mr. Dancer offered, and which seems to be the correct one, is based upon the supposition that in binocular vision we estimate the distance of an object by the degree of convergence of the optic axes. In these experiments, when a flat surface appears concave by the interposition of the prism, the optic axes are made to converge on a point situated behind the real surface, and the imagination gradually removes the object to this apparent distance. When the base of the prism is towards the nose, then the flat surface becomes convex: in this case the optic axes cross in front of the real surface, and the imagination raises the object to that point.

M. Dode, a French chemist, has introduced platinum mirrors, which are greatly admired, and which present this advantage, that the reflecting metal is deposited on the outer surface of the glass, and thus any defect in the latter is concealed. The process, which is patented in France, is described as follows:—Chloride of platinum is first made by dissolving the metal in *aqua regia* and driving off the excess of acid. The neutral chloride is then dissolved in water, and a certain quantity of oil of lavender is added to the solution. The platinum immediately leaves the aqueous solution and passes to the oil, which holds it in suspension in a finely-divided state. To the oil so charged the author adds litharge and borate of lead, and paints a thin coat of this mixture over the surface of the glass, which is then carried to a proper furnace. At a red heat the litharge and borate of lead are fused and cause the adhesion of the platinum to the softened glass. The process is very expeditious. A single baking, M. Dode says, will furnish 200 metres of glass ready for commerce. It would take fifteen days, he says, to coat the same extent with mercury by the ordinary plan.

Photographers have for many years been endeavouring to substitute salts of uranium for salts of silver. One of the most promising of the different suggestions for this purpose has just been made by M. Liesegang. He prepares an ammoniacal citrate of uranium and mixes it with a little solution of chloride of gold and a paste prepared by dissolving tapioca powder in hot water. The quantity of chloride of gold must be small, and the heat not too great, otherwise the gold will be reduced. Spread this mixture with a sponge on paper, which takes a brilliant yellow colour, similar to albuminized paper; when quite dried in the dark, place it in the positive frame. The proofs have all the force and delicacy of those obtained by albuminized paper; the preparation is very sensitive, and becomes more so if slightly moistened. The proofs come from the frame of a bluish black colour; they should not be toned, and should be fixed by being washed with rain-water until the yellow colour of the paper completely disappears.

The picture may be changed to purple by a solution of chloride of tin.

HEAT.—M. H. St. Claire Deville has been for many years occupied with the curious subject of *dissociation*, and on May 1st he presented to the Academy of Sciences a memoir on the phenomena of dissociation in homogeneous flames. It related to the chemical composition and the distribution of heat in a flame produced by a mixture of oxygen and hydrogen, or carbonic oxide and oxygen burnt from an oxy-hydrogen blow-pipe. The author in this paper describes the results with carbonic oxide and oxygen, mixed in the proportion to form carbonic acid. The flame is seen to be composed of an outer and inner cone; the latter composed of the uncombined gases, the former of the gases in combustion. The interior cone had a height of about 10 millimetres, while the more visible part of the exterior cone rose to 70 or 100 millimetres.

The observations show,—

1. That the temperature goes on increasing from the lower part of the flame up to the summit of the interior cone.

2. That the proportion of uncombined gases (oxygen and carbonic oxide) to the combined gas (carbonic acid) increases from the upper part of the dart of flame, where carbonic acid alone was found, down to the lower part (summit of interior cone) where only two-thirds of the oxygen and carbonic oxide had united.

M. Tresca, whose experiments of the flow of solid bodies (soft metals and ceramic pastes) from a small aperture when submitted to great pressure, are known to our readers, has now extended his researches to ice. This body is found to issue in exactly the same way as the solids above mentioned. The jet is formed of perfectly distinct concentric tubes, which, however, in this case are grooved through their entire length with transverse fissures which gave to the jet the appearance of being made up of washers arranged one after another. The results support strongly Dr. Tyndall's theory of constitution of glaciers. Some effects resembling *moraines* were, indeed, seen when coloured ice was employed in the experiments.

At one of the recent meetings of the French Academy of Sciences, M. de Verguette Lamotte made a communication on the effects of heat in the preservation and improvement of wines. Burgundy is well known to be much improved by a voyage to and from Calcutta. This fact led the author to try the effects of warmth on wines at home, and both he and M. Pasteur have come to the conclusion that wines may be much improved by gently warming them, and that sick wines may be cured by the same means. M. Pasteur has, in fact, taken out a patent for warming wines by placing the bottles in a hot-air stove with the corks tied down to prevent their being forced out by the expansion. The bottles must be quite full, and have no air in them, and are heated to 64° C. for half-an-hour, after which the cork is untied, driven home, and sealed down. In the process just described of

course all parasitic ferments are destroyed, and the wines keep well after it.

Our readers are already acquainted with some of the ingenious propositions of M. Tellier to utilize the force evolved in the passage of liquefied ammoniacal gas from the liquid to the gaseous state, and its condensation again by contact with water. He has now proposed some further applications of liquid ammonia. These applications are founded upon two indisputable truths:—1. In empty spaces liquids spontaneously give off vapour, the tension of which immediately reaches its maximum. 2. In two spaces communicating, kept at equal temperatures, and containing one liquid, there is always evaporation in the warmer space and condensation in the colder. The first application suggested is a means of cooling the air of the saloon and cabins of a steamer, say, going down the Red Sea, where the want of cool air is generally experienced. For this purpose he puts liquid ammonia in a sort of tubular boiler, the tubes of which are in free communication with the air and the saloon to be cooled, while the boiler itself is in communication with a worm and receiver bathed with a stream of cold water. The warm air, as it passes through the tubes, parts with its caloric to vapourize the ammonia, and so reaches the cabin delightfully cool, while the ammonia goes on to the receiver to be again condensed. On its way it is utilized to drive a ventilator, supply cold water to the receiver, and pump itself back again to the generator; but by what contrivances and machinery is not stated. A modification of the same plan, as M. Tellier states, is also adapted to cool theatres and other places of entertainment, as well as ships' cabins. More ingenious still is the idea of making the solar rays volatilize ammonia, and so in parching heats manœuvre a pump or pumps which shall irrigate the thirsty earth with refreshing streams, and so make the sun partially undo its own work. More practicable, perhaps, is the idea of using the liquid ammonia to cool the wort in breweries and maintain a constant temperature during fermentation. Remembering that all these ends are to be effected without loss of material, we must give M. Tellier the credit of being one of the greatest inventors or most ingenious theorists of modern times.

A very useful contrivance has been described by Erlenmeyer for managing the application of heat in the distillation of liquids with high-boiling points. A sand-bath is very inconvenient, and a clay-coated retort is often out of the question. The Doctor therefore suggests surrounding the retort with short fibres of asbestos, which he keeps in their place by means of a wire gauze. Such an asbestos bath appears very simple, and will no doubt be perfectly efficacious.

Electricity.—M. Matteucci has studied the battery recently introduced by M. Blanc, who employs a plate of zinc and a plate of lead covered with a very thin deposit of copper, which are placed in a solution of common salt, with which is mixed a quantity of flowers of sulphur. This battery appears to be very useful for telegraphic pur-

poses, and the only objection to its use is the evolution of some sulphuretted hydrogen, which would seem to be unavoidable. In the course of his experiments, the author arrived at the following conclusions:—1. That finely-divided sulphur in contact with the electro-negative metal of a pile formed of zinc, copper, and solution of common salt notably increased the electro-motive force, constancy, and permanency of the battery, and he hopes to obtain by the use of sulphur a voltaic combination possessing many advantages over the batteries at present employed. 2. Sulphur, although insoluble and an insulator, enters into combination with the sodium set free by the current. It remains for the author to explain the action of the small quantity of sulphide of copper which is formed, and which appears to be essential. For this end he has undertaken further experiments.

In a note presented to the Academy of Sciences in May last, M. de la Rive mentioned that a piece of crown or heavy flint glass through which a discharge from a large Rhumkorff is passed, undergoes a permanent molecular modification in its whole extent, losing almost entirely its rotatory magnetic power, and acquiring the properties of a crystalline body, or glass suddenly cooled.

A very interesting paper by M. Morren is given in the March Number of the 'Annales de Chimie et de Physique,' "On the Phosphoresence of Rarefied Gas during the Passage of the Electric Spark." The author endeavoured to discover the cause of the milky-white fog seen in some of Geissler's tribes. It has been attributed by many to the presence of oxygen; but this idea M. Morren shows is incorrect. He finds, in fact, that pure and dry oxygen, however much rarefied, is never phosphorescent; and, indeed, that no gas, simple or compound, is phosphorescent by itself. A mixture of oxygen and nitrogen, with 37 of nitrogen to 100 of oxygen, is feebly phosphorescent; but the phenomenon becomes much more visible when a little vapour of nitric acid is added to the mixture. But it becomes magnificent and lasting when to the preceding mixture a drop of Nordhausen acid or a little vapour of sulphuric acid is added. The same result may be obtained by passing the spark through a rarefied mixture of the following gases:—

Oxygen	500
Nitrogen	200
Sulphurous acid	300
Or,	
Very dry atmospheric air	100
Oxygen	30

And a little Nordhausen or anhydrous sulphuric acid. Other acids besides sulphuric will produce similar results—nitric and carbonic, for example; and the author shows the probability of being able to combine these gases with NO_3. He states that it is possible to form directly the compound NO_32SO_3 by the spark in convenient apparatus.

A note has been read at one of the late meetings of the Académie des Sciences, by M. De la Rive, "On the Conduction of Electricity by Metallic Vapours." These, the author shows, have the same or nearly the same conducting power as the metals in the solid state. The metals were vapourized by the voltaic arc, and on endeavouring to produce the arc with points made of various alloys, the author observed that the alloy was always decomposed. To observe this phenomenon better, he employed a plate of coke for a negative electrode, and the alloy for the positive, and then was able to collect the two metals which deposited separately on the coke.

At the meeting of the Academy of Sciences, held April 17th, M. E. Martin presented a memoir, entitled "An Electro-chemical Study of real Simple Bodies, Ponderable and Imponderable, divided into Two Classes by Peculiar Affinities." The author has arrived at a new science of electro-chemistry, based on the following assumptions, or, as he regards them, proved facts:—1. That the two electricities are not forces, but simple material bodies endowed with chemical properties, by virtue of which they form compounds with simple ponderable bodies. 2. That the two electric fluids of the battery are not produced by any physical action, but by a chemical action of the ponderable bodies which hold them in combination, and which, by uniting with each other, set the electricities at liberty. 3. That these same electricities collected by conductors, and transmitted in currents, participate directly in the actions they produce, and combine chemically with the elements they disunite. We may quote the decomposition and composition of water as an illustration of the author's views. Negative electricity he distinguishes as *electrile*, and gives it the symbol El; positive electricity is *etherile*, symbol Et. The formula of hydrogen becomes, therefore, HEl, and that of oxygen OEt. The two electricities arriving at opposite poles, attracts in the decomposition each its proper element, and we have

$$HO + El + Et = HEl + OEt.$$

The two electricities in uniting with each other produce caloric, symbol C*, and light, L*. Here, then, are the essential principles of electro-chemistry: two electricities possessing peculiar and invariable affinities which unite with each other to form two *imponderable compounds*, heat and light, and with simple ponderable bodies also endowed with peculiar affinities of two kinds. We have thus two classes of bodies:—1. *Oxic*, which includes electrile, an imponderable body, and six ponderable elements, oxygen, fluorine, chlorine, iodine, bromine, and nitrogen; 2. *Basic*, which includes etherile, a simple imponderable body, the basic metalloids, hydrogen, carbon, boron, phosphorus, sulphur, selenium, and silicium, and all the metals. The author concludes—until now chemists have only recognized the effects of chemical union, but have never before discovered the cause—now the cause is manifest; bodies of the same kind are indifferent to each other, but they unite themselves with all bodies of the opposite kind, and the

fundamental law of chemical union thus rests upon the duality of the kinds of simple bodies.

At a subsequent meeting of the *Académie*, M. Martin contributed the second part of his memoir, which he devotes to an explanation of the phenomena of combustion, and of the pile. The simplest case of combustion, according to the author, is that of a mixture of hydrogen and oxygen, which produce water and heat, and which, according to the above theory, is explained by the following equation:—

$$\mathrm{HEl} + \mathrm{OEt} = \mathrm{C}^*.$$

The two imponderables combine to form caloric, which is produced with sufficient intensity to become luminous before it combines with the water. Carbon hold two atoms of electrile, is C,El_2. When it is once burnt in oxygen, it forms carbonic oxide CO,El; burnt a second time with the same quantity of oxygen, it becomes CO_2, in which the two atoms of electrile are replaced by two atoms of oxygen. So with sulphur and the metals.

The action of the battery is a modified combustion in which the two imponderables are kept apart, and sent along different wires.

A most important paper on a new Thermo element is given by M. S. Marcus, in the 'Transactions of the Vienna Academy.' It is also printed in the 'Philosophical Magazine,' No. 197. Bismuth and Antimony are not used in these elements, but in their stead are taken different alloys, the proportions of which are given in the original paper. A powerful thermo-pile was constructed with a view to being used with a gas-flame. The individual elements consist of bars of unequal dimensions. The positive electrical bar is 7″ long, 7″ broad, and $\frac{1}{2}$‴ thick; the negative electrical bar is 6″ long, 7″ broad, and 6‴ thick. Thirty-two such elements were screwed together, so that all positive bars were upon one, and all negative on the other side, and thus had the form of a grating. The battery consists of two such gratings, which are screwed together in a roof shape, and are strengthened by an iron bar. As an insulator between the iron bar and the elements, mica was used. Besides this, the elements, where they came into contact with the cooling water, were coated with soluble glass. An earthen vessel filled with water was used for cooling the lower contact sides of the elements. The entire battery has a length of 2 feet, a breadth of 6 inches, and a height of 6 inches.

M. Marcus communicated further that he had constructed a furnace which was intended for 768 elements. They represent a Bunsen's zinc carbon battery of thirty elements, and consume per diem 240 lbs. of coal.

The following are the properties of the combination:—

1. The electro-motive force of one of the new elements is $\frac{1}{25}$th of that of Bunsen's element, and its resistance is equal to 0·4 of a metre of normal wire.

2. Six such elements can decompose acidulated water.

3. A battery of 125 elements disengaged in a minute 25 cubic centimetres of detonating gas. The decomposition took place under

unfavourable circumstances, for the internal resistance was far greater than that of the interposed voltameter.

4. A platinum wire half a millimetre in thickness introduced into the circuit of the same wire is melted.

5. Thirty elements produce an electro-magnet of 150 lbs. lifting force.

6. The current is produced by heating one of the junctions of the elements, and cooling the second by water of the ordinary temperature.

X. ZOOLOGY.

Including Animal Physiology, the Microscope, and the Transactions of the Zoological Society of London.

Professor Gorini, of Lodi, near Turin, has been engaged for many years past in perfecting a process for preserving dead animals from putrefaction. His preparations of the human body have for some time been so excellent as to look like wax, the lips retaining their natural colour, and the expression being scarcely altered. For the purposes of dissection this method is likely to be of great practical value, as bodies can be retained in a state of softness and freshness for six months. After this time the preparations begin to turn hard and to assume a mummy-like aspect, but immersion in water restores them to their original softness. As yet M. Gorini has kept secret his process of preservation, but it is hoped that in the interests of science he will soon make it public. The process does not seem to be tedious or expensive, for he takes only one day in preparing subjects for future dissection, and for this operation he charges but four shillings. A commission of the Royal Academy of Sciences at Turin reported upon this process at the close of last year, from which report these details are derived. It is not only applicable for anatomical purposes, but can also be employed to preserve specimens of natural history, and to keep butchers' meat from change.

M. Dareste has investigated the facts relating to the coexistence of two embryos upon a single vitellus, first noticed by Wolff, and found that two distinct physiological phenomena are indicated. In the one case the distinct blastoderms are separated from each other in the earliest days of incubation, each presenting its transparent area, which may give rise to an embryo each enveloped in its proper amnios. These two embryos thus remain completely separated, being only mediately united by the vitellus. But in the second case there exists only a single blastoderm, and in this a single transparent area, which is remarkably irregular. The two embryos which are developed in this single, but irregular, area give origin to a single vascular area, and they become united by a single amnios. The two embryos thus developed upon a common transparent area remain in some cases completely isolated, except as regards their indirect union by the vitellus. These both may be developed

normally, or sometimes one of them is imperfectly developed and forms an acephalous monster. In other cases, the two embryos unite directly and produce a double monster. These two modes of coexistence of two embryos upon a single vitellus evidently arise from the fact that in the first case the egg contains two distinct cicatriculæ before incubation; in the second, only one. A double monstrosity, therefore, is not, as was supposed, the result of the fusion of two embryos developed upon distinct vitelli; and M. Dareste maintains that for the formation of a double monster, the embryos must actually originate upon a single transparent area, that is, in a blastoderm proceeding from a single cicatricula. But it remains to be seen why in some cases the two embryos are separately developed, and in others they form a double monster. Another important question arises,—is this single cicatricula, which gives origin sometimes to two distinct embryos, and sometimes to two united ones, really simple, and similar to the ordinary cicatricula; or is it the result of the early fusion of two primarily distinct germs? Since M. Balbiani has shown how the germ is formed in the ovule, we may consider whether certain ovules may not contain a cicatricula apparently simple, but formed by the fusion of two originally distinct germs. And the coexistence of two germs within a single ovule is proved by the coexistence of two separate cicatriculæ upon the same vitellus.

Professor Owen has communicated to the Royal Society an account of the female Echidna (Echidna hystrix) with a young one, received from Dr. Müller, of the Botanic Gardens, Melbourne, in 1865. The young adhered to its mother as was supposed by a nipple. In the parent, Professor Owen found two marsupial pouches, about 1½ inch apart, each with the aperture longitudinal, half-an-inch in depth, and two-thirds of an inch in length. The young Echidna, about one inch in length in a straight line, could be received in a bent position into the pouch, and might cling to the fine hairs of that part by its claws; but there was no trace of a nipple. Each mammary gland terminates by numerous ducts upon the fundus of the corresponding pouch. The author concludes, from the appearance of the uterus and appendages, that this Echidna had produced two young, of which only one was secured, and that probably she had a mammary fœtus in each pouch at the time of capture. The young resembled the young of ornithorhynchus in general shape and curvature of the body, and also the new-born young of the kangaroo in the proportions of the limbs to the body, in the inferior size of the hind pair, and in the feeble indication of eyes and eyelids. The traces of ears, however, are less, the conch being little, if at all, developed in the mature Echidna. The form of the mouth is a transverse slit, and is a good monotrematous character of the young at that period, since in all true or teated marsupials, the mouth of the mammary fœtus has a peculiar circular and tubular shape. A scarcely visible linear cicatrix at the middle of the lower part of the abdomen is the sole trace of umbilicus. There are, however, still points in the generative economy of the monotremes which remain to be determined by actual observation, *viz.* the manner and season of copulation, the period of gestation, the nature and succession

of temporary structure for the nourishment and respiration of the fœtus prior to birth—the size, condition, and powers of the young at the time of exclusion,—the period during which it requires lacteal nourishment,—and the age at which the animal attains full size.

The Rev. Dr. Haughton, of Dublin, has carefully dissected the leg of the ostrich, with a view to determine the peculiar muscular mechanism by which the limb, which may be regarded as a long rod bent at four distinct points, attains its greatest amount of shortening or bending at the moment the foot touches the ground, and is suddenly straightened or elongated by the simultaneous contraction of all the muscles; the effect of which is to throw the whole body of the bird forward from the point of support of the foot as if from a catapult. It is the two-bellied rectus muscle of the thigh which is the key to this remarkable action, which muscle binds down the patellæ, straps up the heel, and brings the whole machine into harmony at the moment that the spring is about to take place. The movements of the ostrich are described by eye-witnesses as admirable, the bird springing from foot to foot in rapid motion, bending with the rapidity of lightning the foot as it left the ground, avoiding skilfully and without apparent effort the dangers of the rough soil. It is said that it almost touches the ground with its body alternately on each side in every successive spring, and leaps with ease over rocks and shrubs of moderate dimensions that lay in its path. The force expended in propelling the body of the ostrich forward is calculated by Dr. Haughton to be ten times the force employed in restoring the legs of the animal preparatory to its next spring, and the question how this force is to be applied suddenly without breaking or dislocating the leg is answered by the remarkable structure of the rectus, which, instead of terminating in the patellæ, passes by a tendon in a groove over and between them, and turning outwards and backwards into the calf of the leg becomes provided with a second muscular belly, which forms one of the portions of the flexor magnus digitorum, the conjoined tendon of which passes under the heel and terminates in the plantar surface of the toe.

Among the curiosities of the Zoological Gardens of late has been a King Penguin (Aptenodytes Pennantii), a bird which, though very common and abundant in its haunts, and very easily caught, has never before been brought alive into Europe. The reason of this appears to be that though they are frequently kept for a time on board ship, they invariably die for want of food, which it seems they generally refuse to take. The present bird was brought on board at the Falkland Islands, with a dozen others, all of which died from refusing food. This one being fatter than his companions survived longer, and being petted and played with by the sailors, was at length induced by them to swallow some fat and fish, and from that time was carefully fed, and brought home in pretty good condition. For some unknown reason, the bird continued to refuse to eat unless the food was actually placed in its mouth by the keeper, when it bolted it voraciously, and by unmistakable gestures asked for more. If a fish were placed on a chair close to its beak, the creature refused to notice it, but followed the keeper's hand with open mouth for another to be

dropped down its throat. Equally strange was its conduct with regard to its native element, the water; for though there was a convenient pond in the enclosure where it was kept, it carefully avoided going into it, and if placed therein, it scuttled out again as soon as possible; yet it evidently likes water, for it enjoys being syringed amazingly, turning its head round, and stooping down so that each part in turn may be well bathed. The consequence of these unaccountable freaks on the part of the Penguin has been that he has at length died, after being but a short time in the gardens. The speculations of Mr. Wallace upon this bird, from a Darwinian point of view, are curious. He considers it a highly specialized form of seabird, which in the process of adaptation to an aquatic mode of life, has reached a stage parallel to that of seals among quadrupeds. Their affinities will, therefore, be general rather than special, since they have become isolated by the extinction of a long series of nearly allied predecessors. Were it not, indeed, that the duty of hatching their eggs and rearing their offspring obliges them to come on shore, the continued modifications of structure in accordance with the requirements of an aquatic life might have been carried still further, and have produced a creature as fish-like among birds, as the whales and dolphins are among mammals.

Professor Steenstrup has contributed a remarkable memoir on the migration of the upper eye of the Flounders across the head from the blind side to the eye side. Calling attention to the obliquity of the Pleuronectidæ, and the curious fact which accompanies their want of symmetry—*viz.* that both eyes are brought round to one side of the head—he remarks that a new system of equilibrium is established for Flounders, in which the dorsal and ventral instead of the lateral halves become symmetrical in outline, and are equipoised. In most of the Pleuronectidæ (Sole), the left is the blind side; but in some (Turbot) it is the right; in both, however, there sometimes occur "wrong Flounders." Besides these there is a group of *double* Flounders, in which the sides are nearly equally developed and coloured, and the eyes placed, one in its ordinary position, and one on the top of the head; these swim vertically. In ordinary Flounders the eyes are not placed in a straight line, one above the other, but the upper eye is somewhat behind or before the lower, usually behind; and between them there stretches a firm, bony partition, formed of definite cranial bones. In the bony cranium there is a single orbit, entirely surronnded by bone, containing the upper eye only; the lower eye lies outside the orbit, and is protected above by the bones which form its lower margin, which are always found to be the frontals and prefrontals belonging to the eye side, and as the lower eye lies under these, it is evident that it is the usual position with reference to the forehead of its own side. And he infers that the eye of the blind side has come round to the (inner) side of the frontal bones of the blind side, which is turned towards the middle line, instead of lying at the outer (now up-turned) side. The old explanation, that the abnormal position of the Flounder's eyes is due simply to a greater or lesser degree of torsion of the whole head upon the axis of the body, or of a part of the

head upon the axis of the head, is insufficient; for, notwithstanding, all the varieties in position, the relations of the upper eye to the surrounding bones of the head remain the same in all forms. This passage of the eye obliquely up through the head has, moreover, been proved by direct observations upon young Flounders. Minute pellucid specimens from the Mediterranean have been described by Rafinesque and Risso, and specimens have lately come under Steenstrup's notice from the Atlantic, about an inch long, having the eyes on the left side, and with them were other small fishes, resembling them in all particulars, save in this—that they were apparently quite symmetrical, with an eye on each side of the head. They were Flounders in an earlier stage. Perfect transitional forms have been noticed, giving "expressive evidence that the eye actually goes from one side up through the head over to the other side—in other words, that the symmetrical (young) fish by degrees squints its eye in and up through the head, out to the other side, and finally squints itself into a perfect Flounder."

The French Museum of Natural History has recently been fortunate enough to succeed in the reproduction of the Mexican Axolotls, which had never before been accomplished in Europe. The Museum possesses in the reptile department six of these animals, five males and one female. The eggs, spawned in the usual manner, consisted, like those of all Batrachians, of a black vitelline sphere, placed in the centre of a transparent vitelline membrane, which was again surrounded by a larger albuminous envelope. Nearly all the eggs were fruitful, and the hatching took place from twenty-eight to thirty days after they were laid. Soon after the egg was quitted, an important change occurred; the buccal cleft opened itself, and the animal fed with avidity upon the animacules floating in the water; in consequence of this, the stomach, which could hardly be recognized in the embryo, now became by degrees quite apparent. M. Dumeril is still engaged in observing the further development of these animals.

The reptiles in the Museum are very interesting generally. The 'Courrier des Sciences' states that in spite of croup, which seems to be the malady *par excellence* of the serpent tribe, there are still living a black trigonocephalus, acquired in 1842; and a tree-frog and freshwater tortoise, dating from 1846 and 1847 respectively. Eight pythons, which measured on leaving the egg four years ago from ·45 to ·5 metre, have now acquired lengths varying from 2·5 to 3·3 metres; and a South American crocodile, which in 1857 was ·3 metre in length, now measures 1½ metre.

In order to encourage the study of Economic Entomology, the Council of the Entomological Society has announced that it has decided to offer two prizes of the value of five guineas each, to be awarded to the authors of memoirs of sufficient merit, and drawn up from personal observation, on the anatomy, economy, or habits of any insect, or group of insects, especially serviceable or obnoxious to mankind. The memoirs should be illustrated by figures of the insects in their different states, and if the species be noxious, they must show

the results of actual experiments made for the prevention of their attacks, or the destruction of the insects themselves. The memoirs must be sent to the Secretary, No. 12, Bedford Row, London, with mottoes, on or before 31st December, 1865, when they will be referred to a committee to decide upon their merits. The prize memoirs shall be the property of, and will be published by, the Society.

A statement of the number of insects in the National Collection may not be uninteresting. The entomological department of the British Museum, we learn from the 'Reader,' contains 130 cabinets, 3,755 drawers, and 121 store boxes, the number of specimens being not less than 904,605. This wealth of species is unequalled in the museums of Europe; but it is rendered almost wholly unproductive of benefits to science from the want of able assistance to place it in order, since there is but one assistant employed in the supervision of the entomological department.

Some observations upon Crustacea have been made by Dr. Fritz Müller, for the purpose of testing the Darwinian hypothesis, on the principle of genealogical classification. Having constructed such a genealogical tree for the Crustacea, he has deduced certain necessary consequences, which if not verified by facts would be a fatal blow to Darwinism; but which, if they proved true, would furnish a strong presumption in favour of the theory. Hitherto his deductions have been verified. Thus in each family of crabs, we find as exceptions to the normal mode of life, certain terrestrial species. It is permissible to suppose *à priori* that these must present certain modifications of the respiratory apparatus to enable them to respire air, and that a multitude of arrangements may be capable of leading to this result. If he found in the terrestrial species of different families the same arrangements for affecting aërial respiration, the Darwinian theory would be irrevocably condemned; but if he should discover differences so complete as not to be reducible to the same type, this would certainly furnish a strong argument in favour of the theory; and the latter alternative has proved to be the true one. The three groups of Crustacea—*viz.* the stalk-eyed, sessile-eyed, and entomostraca—present essentially different modes of development. Darwin's theory, by assigning a common ancestor to all these Crustacea, presupposes that the ancestor itself presented these different modes of development. This hypothesis appears a bold one, and it has been reserved for Dr. Müller to demonstrate its truth, by the discovery of species with a mixed development, presenting the characters of the different groups. The most remarkable of these is a macrourous genus *Peneus*, which quits its egg, not under the form of a Zöea, but under that of a true *Nauplius*, perfectly similar to those of the Entomostraca. The integuments of the Nauplius are then cast off and a true Zöea issues from it, and this Zöea-phase afterwards gives place to one which can only be called a *Mysis*-phase. Finally, a last moult converts this pseudo-Mysis into a true Peneus; nor is this singular mode of development an isolated fact. The sessile-eyed Crustacea (Amphipods and Isopods), should, according to the Darwinian theory, have passed

through a *Nauplius*-phase, or, at least, a *Zöea*-phase, although these phases are wanting in the existing species of which we know the development. Dr. Müller, however, has discovered that the Isopoda of the genus *Tanais* still retain the characters of incontestable Zöea.

A new kind of dimorphism has been remarked by Müller in the males of a species of Tanais. In this species, the individuals of which live together in myriads, the young males closely resemble the females. But the last moult gives rise to two very distinct forms of males. Some of these are furnished with enormous elongated and very mobile nippers, and with antennæ of as many as twelve or even seventeen olfactory filaments, of which the antennæ of the female do not exhibit one. The others retain short and heavy pincers, very similar to those of the females, but their antennæ have incomparably more numerous filaments than those of the first form of males. Müller regards these as two varieties of males, each of which in their way had been selected by peculiar and different advantages adapted to guide them in the search for females, and that therefore this singular fact is not inconsistent with the Darwinian hypothesis.

A remarkable instance of gemmation in an Annelid has been observed by M. L. Vaillant. The animal was a Syllidian from the Gulf of Suez, inhabiting the cavity of a sponge. The segment which bears the leaf-like processes was much broader than the rest of the body, and formed a sort of cup or funnel, representing two thick lips, of which the lower was smooth and simple, whilst the upper one was covered with an immense number of buds placed very close together, and having a very remarkable form, resembling that of some low forms of Annelids allied to Nemertes or Planaria. They had a very contractile body, nearly equal in length to that of the parent animal, flattened and obtuse at the free extremity, where they presented two or four small black eye-like spots. Towards the point of attachment the body became narrowed into an elongated pedicle, and if this were broken, the little creature moved freely in the water by movements of the body, but no vibratile apparatus could be detected. M. Vaillant says these bodies could not be parasites on account of the continuity of their tissue with those of the parent animal, and he does not think they can be regarded as oculiferous tentacles, because great mobility of the eyes occurs only where those organs are very few in number.

In 'Silliman's Journal' it is stated that starfishes may be dried so as to retain their natural colours almost unimpaired, by immersing them in alcohol of moderate strength for about a minute, or just long enough to destroy life and produce contraction of the tissues, and afterwards drying them rapidly by artificial heat, which is best effected by placing them upon an open cloth stretched tightly upon a frame, and supported a few feet above a stove. Care should be taken not to raise the heat too high, as the green shades change to red at a temperature near that of boiling water. The same process is equally applicable to Echini and Crustacea.

Dr. Child, in continuation of his experiments upon the production of organisms in closed vessels, has come to the conclusion that there is no doubt of the fact that *bacteria* can be produced in hermetically-

sealed vessels containing an infusion of organic matter, whether animal or vegetable, though supplied only with air which has passed through a red-hot tube, and though the infusion be thoroughly boiled. The germs of bacterium must therefore be either capable of resisting the boiling temperature of a fluid, or they are spontaneously generated, or they are not organisms at all. With regard to the latter conclusion, although favourable to it at one time, Dr. Child is now convinced that they are really minute vegetable forms. If, however, it be true that *germs* are capable of resisting the boiling temperature of fluid, then both parties in the controversy are working on a false principle, and neither M. Pouchet nor M. Pasteur is likely at present to solve the question of spontaneous generation. In truth, if M. Pasteur's facts are incorrect, the whole question is relegated to the domain of what the French Academy Commission calls "pure discussion," and the one point which Dr. Child claims to have established is precisely that M. Pasteur's facts are inexact; not because his experiments were not most admirably performed, but simply because the magnifying power of his microscope was insufficient for the work to which he applied it. Dr. Child evidently leans to the doctrine of spontaneous generation, and remarks, that the objection, that in exact proportion as our observation of the higher forms of life becomes more exact, we are gradually driven from them to take refuge in the lower forms which we are almost or altogether unable to observe, has little force, since it might be expected that if any forms are generated spontaneously, they will be the very simplest and earliest in the scale of existence, which would be produced under the disadvantageous circumstances in which they must be placed. Dr. Child speaks highly of Powell and Lealand's fiftieth objective, which, he says, has already shown something like an appearance of structure in these minute *bacteria*, which leaves no doubt about their organic character.

A new periodical of much promise has just appeared in German, called 'Archives of Microscopic Anatomy,' conducted by Max Schultze, of Bonn, and published by Max Cohen and Son of that town. It is to be a quarterly journal, illustrated with about thirty plates annually, and each part will cost two thalers subscription. The contents will be original papers upon the Microscopic Anatomy of Man, Animals, and Plants, both Physiological and Pathological, as well as information upon the Microscope itself, and whatever relates thereto.

Professor Agassiz and a party have left New York on the way to South America, on an exploring expedition. His chief object is to make extensive collections in Zoology, and observations in other natural sciences. The expenses of the trip will be defrayed by Mr. Thayer, of Boston, who has most liberally placed his funds at the discretion of the Harvard professor; while the preparations, purchase of instruments, &c., have been at the expense of the Massachusetts Museum of Comparative Zoology, which is to receive the specimens brought home. Very important and interesting results are expected from this expedition, which will probably be absent at least a year.

Mr. R. B. N. Walker, a long resident on the Gaboon, whence he lately brought a remarkable collection of gorilla skins and skeletons,

is about to make an expedition into West Tropical Africa, for the purpose of collecting animals, and for geographical discovery. His hunting-ground will be those little-known regions lying within seven or eight degrees on either side of the Equator, where he will specially occupy himself in search after a lake supposed to be there existent. Mr. Walker may be expected to learn something of the gorilla also, which he says is not nearly so rare as represented by M. du Chaillu, being found in the Dahomey country, and in nearly all the country between that and Congo, as well as being common in the Gaboon and Camma country, where it is sometimes found within three or four miles of the sea. The Royal Geographical Society has agreed to furnish Mr. Walker with the necessary instruments.

The deaths of three eminent Zoologists have been announced during the last quarter. Valenciennes, the celebrated ichthyologist, for many years the *collaborateur* of Cuvier, and the friend of Humboldt, has just succumbed to a long and dangerous illness. William Sharp MacLeay, author of 'Horæ Entomologicæ,' also died at Melbourne on 25th March last. The speculations of this celebrated work have been pushed to extremes by his successors, under the names of the "circular system," "quinarianism," &c., so that they became by-words, and the work of one of the most thoughtful and original of English biologists sank into the most unmerited neglect. Mr. MacLeay cooperated actively and earnestly with his friend, the late Mr. Vigors, in founding what is now one of the most important and flourishing of our scientific bodies, the Zoological Society of London; and also largely contributed to the establishment of the Australian Museum of his adopted country. He subsequently published a work called 'Annulosa Javanica,' besides contributing largely to the scientific periodicals; but since his departure to Australia but little has appeared from his pen. Another eminent Zoologist, and remarkable character, whose death has lately been announced, was Mr. Charles Waterton, of Walton Hall, the author of 'Wanderings in South America.' Mr. Waterton was a simple and earnest naturalist, who has spent more days and weeks and months in the woods than almost any man living, and whose remarkable experiences almost passed the bounds of credit—a circumstance which led to expressions from his reviewers which hurt him greatly. A devoted lover of animals, he formed his park at Walton Hall, near Wakefield, into a perfect paradise for birds and quadrupeds, who were all strictly protected; and his remarkable success in preserving them after death, of illustrations of which his house was well filled, rendered a visit to Walton Hall one of the greatest interest to the lover of Nature. Added to this, the simple and original character of the aged host was itself a study. Mr. Waterton was a stanch Catholic, and was upwards of eighty years of age, hale and hearty. An accidental fall, however, from a rustic bridge in his grounds, produced injuries from which he did not recover.

The Microscope.

Dr. Beale has described to the Royal Society a new object-glass, with a magnifying power double that of a twenty-fifth. This is a *fiftieth*, and magnifies nearly three thousand diameters with the low eye-pieces. Messrs. Powell and Lealand, the makers, produced a sixteenth in 1840, and a twenty-sixth in 1860. The fiftieth defines even better than the twenty-fifth, which is now made instead of the twenty-sixth. Plenty of light for illuminating the object to be examined is obtained by the use of a condenser provided with a thin cap, having an opening not more than the thirtieth of an inch in diameter. The preparation may be covered with the thinnest glass made by Chance, of Birmingham, or with mica, and there is plenty of room for focussing to the lower surface of thin specimens which can alone be examined by high powers as transparent objects. Particles too transparent to be observed by a twenty-fifth are distinctly demonstrated by the fiftieth; and Dr. Beale is of opinion that by the aid of those high powers the further careful study of the development and increase of some of the lowest organisms, and the movements which have been seen to occur in connection with certain forms of living matter, as Amœba, white-blood corpuscles, young epithelial cells, &c., will lead to most valuable results. The finest nerve fibres ramifying in the cornea and in certain forms of connective tissue are also beautifully brought out by this power, and their relation to the delicate processes from the connective tissue corpuscles can be more satisfactorily demonstrated than with the twenty-fifth. The advantage of the fiftieth in such investigations seems mainly due to its remarkable power of penetration. The angular aperture of this glass is 150°. Many twelfths have been made with a higher angular aperture, amounting to 180°.

At the Microscopical Society Mr. Huggins has read a paper "On the Prismatic Examination of Microscopical Objects." The microscopists can hope to profit by prismatic analysis only in the case of those substances which modify the light by a special absorption either during transmission or reflexion. But the discoveries of Professor Stokes in connection with the optical character of blood and chlorophyll, show that even this restricted field of investigation is one of considerable promise. By means of the prismatic microscope, the spectrum of any part of a microscopic object can be examined apart, and also can be compared with the spectra of the adjoining parts of the same object. Thus the spectrum of a single blood disc or of the contents of a single cell can be observed, and changes in living tissues which cause a modification in the spectrum can be watched and investigated. Microscopic physiology may receive some aid from this way of using the prism, since the deepest object-glasses, even the fiftieth, may be employed. The spectra of the light reflected from different parts of the *opaque* object can be separately examined. The plan consists essentially in placing the slit of an ordinary spectrum apparatus in the position usually occupied by the eye-piece of the microscope. Behind the object-glass, at a distance of three or four inches, an adjustible slit is placed, and the object-glass is focussed upon the object,

so that the magnified image shall fall precisely upon the slit. The opening of the narrow slit allows the light of a small part only of the magnified image to pass on to the prisms. Mr. Wenham suggests that it would be convenient to adapt the spectrum apparatus to the direct tube of his binocular microscope, as then by looking into the other tube furnished with an eye-piece the particular part of the object under investigation with the spectroscope could be easily determined.

Mr. Bridgeman, of Norwich, proposes an improvement in the Lieberkühn for examining opaque objects with a binocular, which shall place the quantity, quality, and direction of light under complete control. It consists of covering up a portion of the reflecting surface of the Lieberkühn, so as to obtain any proportion of oblique light in one particular direction, and then by rotating the Lieberkühn upon the object-glass, it may be brought to bear upon every part successively without having to alter the position of the object. In this way the most delicate structure, as the barbs upon the nearly transparent spines of *Opuntia tunicata*, may be brought out into full and bold relief. The elegant arrangement of crystallized silver can scarcely be seen to advantage in any other way. He proposes to fix a triangular piece of thin, dull, black paper upon the silver with gum, and when dry to trim off the projecting parts from the centre and circumference with a sharp penknife, so as to give it a neat appearance. The tube of the Lieberkühn should move freely upon the object-glass, and be provided with a milled ring, so as to be easily rotated between the finger and thumb.

Zoological Society of London.

During the past quarter, the annual meeting of the Society has been held, and the Council's Report, with much interesting matter, shows that the Society is financially and otherwise in a state of great prosperity. There were nearly two thousand fellows and subscribers upon the roll, and the receipts from their subscriptions, added to that of visitors to the gardens, produced an income for 1864 of 21,713*l*., or 1,429*l*. in excess of the previous year. Upwards of half a million persons had visited the menagerie during the past year, a number exceeding that of any year except the Exhibition years of 1851 and 1862. The expenditure, ordinary and extraordinary, of the past year amounted to 24,889*l*., and the present state of the finances shows that, leaving out of account a reserve fund of 10,000*l*. 3 per Cents., which it is not contemplated to increase, there is still a balance available to be added to the receipts of the present year.

During the year 1864, extensive additions had been made to the buildings in the gardens, including entrance lodges, an aviary, and the new monkey-house. The total cost of the last amounted to 4,842*l*., but this expenditure would be well repaid by the increased attraction to the public, and the increased attention to the welfare and health of the Quadrumana contained in it. In striking contrast to the constant mortality that had prevailed in the old monkey-house,

the deaths among them during the late long and severe winter had been very few, and the greater number of them had remained in a state of excellent health. In addition to a crowd of smaller Quadrumana, there is at present a red orang and a black chimpanzee in the house, both of which are well worthy of attention; and for the first time, these anthropoid apes have passed a winter without contracting cough or consumption. Moreover, the atmosphere of the house presents an agreeable contrast to that of the former small and confined building, in which it was impossible to remain for any length of time; and, doubtless, the present admirable structure will be greatly improved in process of time, as various suggestions offer themselves, so that when the long-desired gorilla arrives, there shall be no reason why he should not be long kept alive and in health. Last year, a most interesting series of rare quadrumana was obtained, among them were numerous spider monkeys and red howlers, and the rare Lagothrix Humboldtii, which died most probably from insufficient accommodation. The expenditure of so large a sum in a properly-constituted house is, therefore, true economy.

During the year 1864, there were exhibited for the first time eight mammals, including the orange-quilled porcupine (Hystrix Malabarica), twenty-three birds, including the tooth-billed pigeon (Didunculus strigirostris) of the Samoān Islands, supposed, until recently, to be quite extinct, as well as two reptiles and two fishes. There have also bred in the menagerie, during the year, twenty-two species of mammals, twenty species of birds, one reptile, and three fishes.

An important movement has also been made in the Society during the last quarter. The Council resolved to appoint a 'Prosector' in the gardens, at a salary of 250*l.* per annum, whose duty it should be to make dissections of the animals which die in the menagerie, and have not been promised elsewhere. If the Zootomical Committee shall have disposed of the skin, or skeleton, or both, an examination will be made to determine the cause of death, so far as it can be made without injury to the skin or skeleton,—and an accurate record will be kept of the dissections, or other anatomical or physiological work performed; and such parts of the record as may be approved by the Committee will be presented by the prosector to the Society, at its scientific meetings, for publication in the Proceedings or Transactions. For this desirable post, there were twenty-eight candidates, from whom the Council selected Dr. James Murie, of the University of Glasgow, formerly Pathologist to the Glasgow Infirmary, and afterwards Assistant in the Museum of the Royal College of Surgeons, Lincoln's-Inn-Fields. Dr. Murie left the College of Surgeons to join Consul Petherick's expedition to the White Nile, as naturalist, and there made extensive collections in natural history. The same gentleman has communicated a paper to the Society, in March last, upon the muscular system of the curious little Hyrax, or coney, which, being a pachydermatous animal, in so many points resembles the rodent type. Also papers "On the Anatomy of the Lemur, *Nycticebus tardigradus;*" "On the Sperm Whale," &c.

At the ordinary meeting of the Society, many interesting papers have been read. Mr. Sclater's communications pointed out the accessions to the menagerie, and incidents of interest which from time to time took place, such as the laying of eggs by the rarer birds. Not so many birds as usual appear to have fallen to the lot of Mr. Sclater for description, the chief being a new genus of Passerine birds from Madagascar, and a new species from British Guiana. Dr. Gray's papers have chiefly had reference, as usual, to mammals, and the porpoise, which lately died in the menagerie, afforded a text for an interesting communication. It was remarkable for having a row of tubercles on the upper margin of the dorsal fin. This structure did not appear to have been previously noticed in the common porpoise, although a species from South America, lately described by Dr. Burmeister, possessed it in a highly-developed degree. This latter species was taken alive at the mouth of the Rio de la Plata, and described by Burmeister as a new species, under the name of *Phocœna spinipinnis.* Further examination of the British specimen showed that it possessed a striking difference from the common porpoise in the shape of the occipital foramen, and has induced Dr. Gray to consider it as a new species, which he calls *P. tuberculifera.* A useful revision of the insectivorous Edentata has also been prepared by Dr. Gray from the specimens in the British Museum, amongst which he has found two species heretofore undescribed. A notice of a new species of porcupine from South America, and of a genus of tortoise from West Africa, are also among Dr. Gray's contributions.

Mr. E. S. Layard, a brother of the Under-secretary, resident at Cape Town, is from time to time adding new material to Zoological Science, and now sends accounts of two whales in the South African Museum, which Dr. Gray considers to be new species, and calls *Ziphius Layardii*, and *Hyperöodon capensis.* He also sends a description of a new zebra discovered by Mr. Chapman in the interior of S. W. Africa.

Professor Huxley has described his researches into the anatomy of bats, in the genus *Desmodus*, of which he has found a singular form of stomach, in which the cardiac end of this organ assumes the form of a greatly elongated cæcum reflexed upon itself. This character, added to peculiarities of dentition, seems to him to indicate the necessity of constituting this genus, with the allied form *Diphylla*, in a separate section of the Order of Bats.

The remarkable discovery of a preserved Dinornis, now in the York Museum, has given Mr. Dallas, the Curator, an opportunity of examining the feathers of that extinct bird. He has given a full description of their structure, and shows that the remnants of the large accessory plume attached to each feather manifests a near relationship between Dinornis, and the Emeus and Cassowaries. Mr. Newton exhibited and described a number of hitherto unknown, or little known, birds' eggs. Among them were those of the tooth-billed pigeon, the Opisthocomus, and the nutcracker, &c. He believed that the eggs of the nutcracker (*Nucifraga caryocatactes*) which had been

obtained from the island of Bornholm, were the first really authentic examples which had reached this country.

Fishes have not been neglected, and a memoir of those of Cochin, on the Malabar coast of India, has been read by Mr. F. Day. This gentleman has obtained in this locality 210 species, of which about one-tenth were previously unknown. The indefatigable researches of Mr. J. Yate Johnson, in Madeira, have also been again rewarded by a new form of trichiuroid fishes, which he calls *Nealotus tripes*.

The land- and fresh-water shells of the Zambesi and Lake Nyassa have been the subject of a communication from Dr. Kirk. The land shells of the Malay Archipelago, collected by Mr. Wallace, have been described by him, in conjunction with Mr. H. Adams; and Dr. P. P. Carpenter has communicated three papers upon the shells of Panama, Mazatlan, and the West Tropical region of North America. In addition to these papers, interesting communications have also been read by Dr. Crisp, Dr. Murie, Dr. W. Peters, Dr. Hartlaub, and other eminent Zoologists.

XI. SCIENCE IN CANADA.

Botany.—*Filices.* In the 'Canadian Naturalist and Geologist' we find a Synopsis of Canadian ferns and filicoid plants, by George Lawson, Ph. D., LL.D., and a paper on the same subject, serving as a supplement to the former, by David R. McCord, B.A. The whole number of Canadian species that have been enumerated is seventy-four, of which eleven are doubtful. Of the sixty-three certainly known, fifty-eight are inhabitants of the Northern United States, thirty-eight of the Southern States, and thirty-six are found in Europe. Dr. Lawson gives a list of the seventy-four species, showing their occurrence in Canada, the Northern States, the Southern States, Europe, Continental and British, and within the Arctic Circle, respectively. The table is followed by a description of the species, with the localities where they have been observed. Mr. McCord's list contains additional localities in Lower Canada, those given by Dr. Lawson being chiefly Upper Canadian. Amongst well-known British ferns occurring in the Colony, we observe that Polypodium vulgare is common in Lower Canada, and widely distributed, though not very common, in Upper Canada. Pteris aquilina, Athyrium filix-fœmina, and Lastrea dilatata are common in both provinces; and Lastrea cristata, Woodsia Ilvensis, Osmunda regalis (represented by the var. β spectabilis), and Botrychium Lunaria, are not uncommon. Asplenium trichomanes, and Polystichum augulare are rare, whilst Scolopendrium vulgare, Asplenium viride, and Ophioglossum vulgatum have each been found in one locality only, the first in Upper Canada, the two latter in Lower Canada. On the other hand, we miss our British Aspidium Oreopteris, Lastræa filix-mas (recently, however, found on the Rocky Mountains), Asplenium adiantum-nigrum, and Blechnum boreale. Of the seventy-four species of filices described,

six are peculiar (so far as is yet known) to Upper Canada. Five species, *viz.* Struthiopteris Germanica, Plananthus lucidulus, Lycopodium complanatum, Salvinia natans, and Equisetum scirpoides are common to Canada and to Continental Europe, but are not found in the British Islands. In speaking of Equisetum, Dr. Lawson remarks on the great value of E. limosum and of E. arvense as fodder plants; on the Western prairies, horses are said to get "rolling fat" on equisetum in ten days. With regard to the habitats of Canadian ferns, Mr. McCord remarks that more than half of the Lower Canadian ferns are inhabitants of moist tracts, being found either in open meadows or in swamps; the remainder grow upon rocks with little moisture, as Woodsia Ilvensis, Cystopteris fragilis (occasionally), and Allosorus gracilis; or upon rocky positions but requiring moisture, as Asplenium trichomanes: in the latter case they suffer during dry seasons.

Calluna vulgaris, the common British ling or heather, has been found in Cape Breton. It had previously been noticed in the south-east peninsula of Newfoundland, and in Massachusetts. These with Greenland (according to Giesecke) form the only known localities of this plant in America.

Geographical distribution of Canadian plants. Mr. A. T. Drummond, B.A., LL.B., contributes to the 'Canadian Naturalist' a valuable paper on Canadian Geographical Botany. He distributes the plants hitherto found, into five groups, excluding in his enumeration mosses, lichens, and lower forms. The groups are thus distinguished:—*I. Canadian type*—Species generally distributed through the whole or greater part of the province. *II. Erie type*—Species chiefly restricted to the district bordering Lake Erie. *III. Superior type*—Species only found about Lake Huron and Superior, and most of which have evidently migrated from the country watered by the Sashatchewan. *IV. Maritime type*—Species confined to the seashore. *V. Alpine type*—Species chiefly known, at present, to occur about the north-eastern borders of the province. The English botanist will be interested in observing the relation held by the various groups to the flora familiar to him; and we have therefore made a comparison between Mr. Drummond's lists and the accepted lists of British plants.

I. *Canadian type.*—The list includes fifty-two species belonging to forty-five genera. Of the genera thirty-eight are represented in Britain. Of the species twelve are British, *viz.* Ranunculus repens, Caltha palustris, Nasturtium palustre, Drosera rotundifolia, Lathyrus palustris, Epilobium angustifolium, Linnæa borealis, Menyanthes trifoliata, Equisetum sylvaticum, E. arvense, Polypodium vulgare, and Asplenium filix-fæmina. There are also the semi-British Impatiens fulva and Antennaria margaritacea. The natural orders best represented are Rosaceæ and Ericaceæ amongst the larger, and Coniferæ and Betulaceæ amongst the smaller orders.

II. *Erie type.*—Genera forty-two, species forty-eight, of which are British—genera seventeen, species, none. The forests bordering Lake Erie have abundance of beech (Fagus ferruginea), sugar-maple (Acer saccharinum), oak (Quercus rubra, Q. macrocarpa, and Q. alba), and

walnut (Juglans nigra). The flora of this district resembles that of the western part of New York State.

III. *Superior type.*—Amongst the species of this district, Mr. Drummond mentions thirty-seven, belonging to thirty-two genera. Twenty-six of the genera are British, but only nine species, *viz.* Arabis petræa, Linum perenne, Matricaria inodora, Melampyrum pratense, Polemonium cæruleum, Humulus lupulus, Carex Vahlii, and Aspidium lonchitis. Some few species, which in the United States are north-western plants, reappear near the north-eastern Canadian boundary line. Thus Parnassia palustris, a species of Upper Michigan, the Lake Superior region, and north-westward, likewise occurs in Labrador and Newfoundland. Under the preceding types the lists given are representative, not complete. The next list includes all yet known.

IV. *Maritime type.*—Genera twenty-six, of which twenty-one are British; species twenty-eight, of which fourteen are British; *viz.* Honkenya peploides, Spergularia marina, Lathyrus maritimus, Ligusticum Scoticum, Plantago maritima, Armeria vulgaris, Glaux maritima, Mertensia maritima, Salicornia herbacea, Chenopodina maritima, Salsola Kali, Triglochin maritimum, T. palustre, and Juncus bulbosus. It is remarkable that many maritime species occur in the neighbourhood of the great lakes; thus, at least eight truly sea-shore plants have been found near Lake Superior. Many are also found inland near salt springs. It is suggested that these facts indicate the former partial submergence of the country, when the sea-shore was much farther inland than now.

V. *Alpine type.*—Of strictly Alpine character Mr. Drummond mentions twenty-nine species belonging to twenty-six genera. Twenty-three of the genera are British, including the following fourteen species:—Thalictrum alpinum, Draba incana, Viola palustris, Sibbaldia procumbens, Rubus arcticus, Epilobium Alpinum, Sedum Rhodiola, Saxifraga stellaris, S. nivalis, Erigeron acre, Arctostaphylos alpina, Betula nana, Salix reticulata, and S. repens.

The list of sub-Alpine species contains nineteen genera, of which sixteen are British; and twenty-two species, of which fourteen are British, *viz.* Rubus Chamæmorus, Solidago virgaurea, Vaccinum uliginosum, V. Vitis-Idæa, Euphrasia officinalis, Polygonum viviparum, Empetrum nigrum, Tofieldia palustris, Scirpus cæspitosus, Poa alpina, Phleum alpinum, Woodsia alpina, Asplenium viride, and Lycopodium Selago.

It is to be regretted that the names of the species in Mr. Drummond's lists are without the affix indicating their authority. In the present day, when descriptive natural history is crowded with synonyms, and when scarcely two naturalists agree in specific arrangement, a name cannot be considered definite, unless that of its originator is added.

Michaux.—The Abbé Ovide Brunet, professor of botany at the Laval University, Quebec, has collected sufficient materials to enable him to give for the first time a tolerably complete account of the travels of the botanist André Michaux, through Canada. His paper,

of which a translation appears in the 'Canadian Naturalist,' is extremely interesting; and is rich in information concerning the distribution of plants throughout that part of the province round Lake St. John, and adjacent to Hudson's Bay. It also furnishes a good general description of the district, which is but little known. The lists of plants include many well-known British species, whilst the number of genera foreign to Britain is extremely small.

Entomology.—*Pieris rapæ.*—Mr. G. J. Bowles, Secretary to the Quebec branch of the Entomological Society of Canada, read a paper before the branch Society "On the Pieris rapæ (or Pontia rapæ)," which is the small white cabbage butterfly, common in England, where it is very destructive. He states that it is now present in considerable numbers within a radius of about forty miles round Quebec. It appears to have been first introduced into the province at that city about seven or eight years ago, being probably brought over amongst vegetable produce. Two males of a bright canary colour, a variety occasionally taken in England, have been captured. In the autumn of 1863, the ravages of the larvæ, in the vicinity of Quebec, were very great. Several specimens collected by Mr. Bowles showed that they are attacked by a parasite, probably one of the Ichneumonidæ. (This is also the case in Britain.) Mr. Bowles describes the insects in order that farmers and gardeners may recognize and destroy them.

Entomological Society of Canada.—This Society has resolved to prepare and publish catalogues of all the known Canadian insects; commencing with the Coleoptera and Lepidoptera. This is an example well worthy of imitation by all local and provincial Natural History Societies.

Attacus polyphemus.—In August, 1863, Mr. Wm. Couper, of Quebec, found two caterpillars of this lepidopter feeding on sweet-briar, a plant said to be introduced into Canada. The food-plants previously ascribed to it, were the oak, elm, and lime trees. It has also been found on the maple; but as the larva is large, soft, thin-skinned, and hairless, its occurrence on the thorny briar is remarkable. Mr. Couper kept the two specimens in confinement on this plant, until they commenced spinning, previously to which, they ejected the contents of the viscera, consisting of about a teaspoonful of a dark green fluid.

Gall of Triticum repens.—The same observer describes the occurrence on Triticum repens, Linn. (the creeping wheat-grass or couch-grass), of a gall produced by a hymenopterous insect of the genus Eurytoma (possibly E. fulvipes). The insect appears in June, when the female deposits an egg in each joint of the grass, producing a gall, which appears externally as a tumid part of the stem. As soon as the larva issues from the egg, it places its head downwards in the gall, remaining in that position until it eats its way through. During the winter, it remains torpid in the hardened gall, becoming active again in the following spring, and changing to the perfect insect in time to attack the young grass.

Geology and Palæontology.—*The Geology of the Ottawa Valley* has been described in a lecture delivered before the Ottawa Natural History Society, by Jas. A. Grant, M.D., F.R.C.S.E., F.G.S. The whole of the rocks beneath the drift are older than the grey sandstone of the New York series, which corresponds to the Llandovery beds or Middle Silurian of Britain (see 'Report of Geology of Canada, Murchison's Siluria,' chap. xviii., and 'Lyell's Elements of Geology,' 6th edition, p. 566). The lowest formation described (leaving out the metamorphic rocks) is the Potsdam sandstone, equivalent to the Upper Cambrian of Lyell, and to the lowest members of the Lower Silurian of the Geological Survey of Britain. It crosses from New York State into Canada, being well developed in the county of Beauharnois (see 'Lyell's Elements,' p. 577). Above this is the Calciferous Sand-Rock, which, in that part of Canada, is principally a granular magnesian limestone, with some imperfect fossils. Its thickness is about 300 feet. The Chazy limestone, next in the series is, in Canada, associated with sandstones and shale. It forms a zone around the Geological depression between the Ottawa and the St. Lawrence. Above this formation is a great mass of limestones, divided by the New York Geologists into three formations—the Bird's-eye limestone, the Black River limestone, and the Trenton limestone. In Canada, however, these divisions are indistinguishable, either lithologically or palæontologically, consequently they are united, and constitute the Trenton group, which forms, according to Sir W. Logan, one of the most persistent and conspicuously marked members of the Lower Silurian rocks of North America. It is found largely round the city of Ottawa. Its thickness is probably not less than 600 feet; but dislocations make the amount difficult to estimate. The next formation is the Utica Slate, consisting of dark-brown bituminous shales, interstratified here and there with a few beds of dark limestone. In some places, the shale is sufficiently bituminous to produce mineral oil in considerable quantity. The drift formation extends over North America, north of the parallel 40°, and forms the surface of country over a great part of the triangular area included by the St. Lawrence and Ottawa rivers. It consists of stratified clays and sand, with erratic boulders, many of them of great size. The channel of the Ottawa is contracted in various places by ridges of drift. The post-glacial beds are divided by Dr. Dawson into two series, the lower being the Leda Clay, a deep-sea deposit; the upper, the Saxicava Sand, formed in shallow waters. Amongst the clay fossils are Saxicava rugosa, Tellina Greenlandica, and the Mallotus villosus or capeling of the lower St. Lawrence. [This is the little fish mentioned by Agassiz as the only tertiary species which he was able to identify with a living form. It is found in nodules of clay in Greenland. "These nodules exemplify the operation of the dissolving soft parts of the fish in consolidating the surrounding matrix," 'Owen's Palæontology,' 2nd edition, p. 174.] The same fossil is found in nodules, in clay at Fort Coulogne Lake, at 365 feet above the sea. Most of the boulders are composed of gneiss, either ordinary or hornblendic. [In connection with this subject, see an interesting

paper by Professor Hind, of Toronto, on the "Drift of Labrador, &c.;" 'Quarterly Journal, Geological Society,' vol. xx., p. 122, May 1864; and 'Canadian Naturalist' for Aug., 1864.] Dr. Grant next describes the "rock-basins" or "pot-holes," which are everywhere common along rapid brooks and rivers, and are most frequently seen on elevated ground. Two of considerable dimensions occur near Ottawa, one being three feet in diameter and thirteen in depth, the other ten feet in diameter and fifteen to twenty in depth.

Geology of Eastern New York.—Dr. T. Sterry Hunt gives, in the 'Canadian Naturalist,' a short account of the results arrived at by Professor James Hall and Sir William E. Logan, in the examination of the rocks of Eastern New York, with the object of comparing them with Canadian formations. These gentlemen succeeded in recognizing the Sillery and Quebec groups in that region, and also in identifying the gneissic district of the Highlands of the Hudson with the Lawrentian system of Canada. This conclusion agrees with the observations of Professor Cook, and of Vanuxem and Keating, according to all of whom the gneiss and crystalline limestones of Orange County and of New Jersey underlie unconformably the Lower Silurian strata.

The Gold of Nova Scotia.—Mr. G. F. Hartt shows that, in Colchester County, N.S., auriferous clay-slates, similar to those of the other gold districts of the province, are overlaid unconformably by sandstone, grit, and conglomerate of Carboniferous, probably Lower Coal-measure, age. At the junction the conglomerate and grit are richly auriferous—the greater part of the gold mined in the locality being obtained from the conglomerate. The inference is drawn that the gold is of pre-Carboniferous age, both in that locality and elsewhere in the province.

Tracks and Feet of Trilobites.—At a meeting of the Canadian Natural History Society, held on September 26th, 1864, two interesting and important papers were read, bearing on the nature of Trilobites. The first was by Principal Dawson, on the genus *Rusophycus*. This genus was established by Professor Hall, for certain transversely wrinkled impressions found in the Clinton group and Chazy sandstone, and supposed to be fucoids.* Mr. Billings thus describes the species found in the Chazy sandstone of Grenville:—"This species (R. Grenvillensis) is found in the form of irregular, oblong-ovate, or depressed hemispherical masses, one end usually divided into two parts by a furrow of more or less depth. The whole mass is generally crossed by numerous undulating wrinkles, which have a transverse direction to that of the furrow. The more common dimensions are from three to four inches in length, and from two and a-half to three and a-half in breadth, but occasionally specimens occur much larger and also smaller; one of them is nine and a-half inches by five and a-half, and, in addition to the principal groove, exhibits two or three obscure furrows on each side." Dr. Dawson adds that the longitudinal furrow is always more strongly marked at one extremity of the fossil, and that there is no indication of a stem or stalk. From an examination of the fossils *in situ*, Dr. Dawson concluded that they were casts of hollows or holes excavated in clay, and afterwards filled with sand.

The appearances can be explained on the supposition that some animal crawling on the soft mud at the bottom of shallow water, by means of feet which made a double series of transverse marks, was in the habit of excavating deep burrows for shelter or repose. The burrowing of the modern *Limulus* would produce a similar effect, with the addition, however, of the mark of the caudal spine, of which these fossils show no trace. Hence the animal required would be a crustacean, having feet and habits of life generally resembling those of *Limulus*, but without a caudal spine. Such were trilobites; and in particular the feet of *Asaphus*, as discovered by Mr. Billings, would appear to be precisely what would produce the markings. Dr. Dawson thinks it probable that the burrows were places of incubation, and that the tribolites carried their spawn attached to their swimming feet, and were in the habit of resorting to shallow water for the purpose of incubation. He proposes to change the generic name to *Rusichnites;* and he thinks it probable that the Grenville specimens may belong to three species of tribolites. Similar fossils from the Lower Carboniferous of Nova Scotia are named *R. Carbonarius.* Lastly a species from Cape Breton, called *R. Acadicus* (figured in the 'Canadian Naturalist' for December, 1864), seems to be the track of the swimming feet and edges of the carapace of a small *Limulus.*

The second paper was by Mr. Billings, "On a remarkable specimen of *Asaphus platycephalus.*" The author exhibited a specimen of this tribolite from the Trenton Limestone of Ottawa, which had been in part carefully extricated from the matrix. The specimen had eight thoracic segments, and exhibited on the under side eight semi-cylindrical ridges on each side of the median line, all curving outwards and forwards. Mr. Billings believed these to be the bases of attachment of eight pairs of swimming feet. Burmeister's supposition as to the nature of the legs of tribolites was fully borne out by this discovery, except that in Burmeister's sketch the limbs are directed backwards. The legs were probably thin and foliaceous.

Apatite (phosphate of lime), according to a paper by Dr. T. S. Hunt, occurs abundantly in several parts of Canada, as in the vicinity of Perth, and at several points along the Ottawa. It is found disseminated in small crystals through Lawrentian crystalline limestones, and in regular veins which intersect the rocks of the same system. In the latter case it is sometimes nearly pure; at other times it is associated with pyroxene, large crystals of magnesian mica (which are wrought), and other silicated minerals. Attempts are now being made to work the deposits of this mineral in North Burgess.

ZOOLOGY.—*Classification.*—An important paper by Dr. Dawson "On the Classification of Animals," appears in the 'Canadian Naturalist.' It is difficult in a few words to give a summary of the views of the author, but the following are some of the salient points:—First, with regard to species. The essential characters of a species are points of structure, proportion of parts, ornamentation and habits; but it is also necessary to take into account its continued existence in time, and we are therefore brought to the definition of species long ago proposed by

Cuvier and De Candolle, which unites in one species all those individuals which so resemble each other that we may reasonably infer that they have descended from a common ancestry. Such a definition is, for practical purposes, unaffected by the Darwinian hypothesis. The origin of the first individuals of a species may be, and probably is, a problem not within the province of natural history. Of vital force, and of creative force or power, we are ignorant. We know nothing, except by inference, of its laws, and we must always be obliged to pause at the line where what we call force resolves itself into the will of the supreme spiritual Power. The species is a natural, the genus an artificial group; they differ not in degree, but in kind. There are four distinct grounds on which comparisons may be made for purposes of classification. These are: 1st, intimate structural resemblance, used in forming *genera;* 2nd, grade or rank, as to complexity of structure or development of the highest functions, used for distinguishing *orders;* 3rd, use or function, referring to special development of the nervous, motive, nutritive, or reproductive function respectively, enabling us to group animals into *classes;* and 4th, plan or type, enabling the naturalist to mark the primary division of animals into *provinces.* Dr. Dawson adopts Cuvier's fourfold division into Vertebrata, Articulata, Mollusca, and Radiata, considering it to be by much the most natural and philosophical yet proposed. He regards as retrograde the attempts to introduce additional branches or provinces, such as the Protozoa of Siebold, the Cœlenterata of Leuckart, and the provinces Molluscoida and Annuloida of Huxley.

The following is his table of classes:—

Table of Classes of Animals.

Provinces or Branches.	Vertebrata.	Articulata.	Mollusca.	Radiata.
1. Nervous class.	*Mammalia.*	*Arachnida.*	*Cephalopoda.*	*Echinodermata*
2. Motive class.	*Aves.*	*Insecta.*	*Gasteropoda* (including *Pteropoda.*)	*Acalephæ.*
3. Nutritive class.	*Reptilia.*	*Crustacea.*	*Lamellibranchiate.*	*Anthozoa.*
4. Embryonic or Reproductive class.	*Pisces.*	*Annulata,*	*Molluscoida* (including *Tunicata, Brachiopoda,* and *Bryozoa*).	*Protozoa.*

XII. SCIENCE IN THE PROVINCES.

Local Museums and Provincial Societies.—It has of late been frequently insisted upon, that the main objects of the various Natural History Societies which exist throughout the country should always be the examination of the phenomena displayed in their immediate neighbourhood, that they should deal principally with local and, to a less extent with general, subjects. In like manner a local museum, it has been observed, should, above all things, include an assemblage of objects, representing, as completely as it is possible, the natural history, archæology, &c., of its own district. But a truth of this kind cannot be too often reiterated, nor too generally known; and we are therefore happy to find it well enunciated in a lecture delivered to the members of the Bath Natural History and Antiquarian Field Club by the Rev. Leonard Jenyns, M.A., President. The address remarks that in national museums, we expect and ought to find everything known to exist in the several classes of the animal, vegetable, and mineral kingdoms, so far as they can be acquired. But local establishments will have limited space and funds, and must, therefore, make a judicious selection. In the first formation of a museum it is not necessary to be over-particular, as objects which arouse the curiosity of the uneducated may excite a taste for the works of Nature or Art. But beyond this there must be method and principle. The provincial museum should, in the first instance, collect the productions of its own neighbourhood, for the sake not only of local students, but of visitors from other districts. The next suitable object, if there be sufficient means, may be the collection of the productions of Great Britain, and next, of other parts of the world; but in either case the collection should be purely typical—excluding closely-allied species, varieties, &c. Another recommendation is the representation by specimens of the whole life of an organism, its habits, uses, allies, and enemies: for instance, cases of insects injurious to corn or timber, showing every part of their history, with examples of others appointed to keep them in check; gall-making insects; nest-building insects, &c. It is well observed that very much of the usefulness of a museum depends on the proper labelling of the specimens, which should not be a mere series of names, but should include a short account of affinities, structure, or uses; a system exemplified at the Kew Museum of economic botany.

On this head we may refer to the excellent arrangement of the Mollusca adopted at the Liverpool Free Museum, under the superintendence of the Rev. H. H. Higgins. The visitor has before him a short account of the group he is examining, typical British specimens, typical Foreign specimens, fossil representatives, and illustrations of uses. In the accompanying cabinets, for the use of students, are collections of allied species; where necessary, there are also well-drawn illustrative diagrams.

On the same subject is a paper, read before the Dudley and Midland Field Club by Mr. John Jones, the Secretary, and headed,

"Organization in Field-Club Work." The author makes an earnest appeal to his fellow-members to work out the science of the district, instancing as desirable objects the formation of a "Midland Flora;" the history of the names of Midland families and places; the study of the Coal Measure fossils, particularly with reference to the various beds; the examination of the "Permian breccia;" and other similar topics. He recommends for imitation (and we cordially agree with his recommendation) the example of the members of the Malvern Club, who are collecting materials for a Scientific Guide Book to their district. He is also anxious that the Society should take up the discussion of questions of practical mining, obtaining the co-operation of those engaged in the pursuit. It will be seen that this suggestion has already been acted upon.

The Dudley and Midland Geological and Scientific Society and Field Club.—This Society appears to be in a very flourishing condition, its 'Transactions' giving evidence of a considerable amount of work done, and of results obtained. There are two or three special features worthy of notice. Its object, according to the revised list of rules, is "to amass and diffuse practical and theoretical information respecting Geology and other sciences by the reading of papers and discussions thereon; the delivery of lectures; the formation of a library and museum; the collection of plans and general statistics relating to Mining; the publication of the Society's proceedings; by holding field-meetings; arranging scientific exhibitions in various towns in the district; and by such further means as the Committee may see fit to adopt from time to time." We find that a conversazione and exhibition of fossils, botanical specimens, diagrams, and philosophical apparatus was organized by the Society, and held at Wolverhampton in January, 1864. During the evening, papers were read "On the Working of Mines in South Staffordshire;" "On Roman Mosaics found in Britain;" "On Palæozoic Genera still existing;" and "On the Literature of Geology." In the following April, a Fine Arts, Industrial, and Scientific Exhibition was held at Dudley, which appears to have been very attractive and successful, except perhaps pecuniarily. A balance on the debtor side, however, must be considered not as so much lost, but as expenditure resulting in the accession of new members and the spread of scientific or artistic tastes. At an evening meeting held during the exhibition, Lord Lyttelton presiding, a paper was read by the Rev. W. Symonds, F.G.S., Rector of Pendock, and President of the Malvern Field Club, "On the Progress of Geological Science during the previous year." The author gave a masterly sketch of the geological discoveries of the year, including a summary of Sir Charles Lyell's conclusions on the antiquity of man. In conclusion, he remarks, "Taking the whole testimony, there can be little doubt that man, the pre-eminent creature on this planet of his Creator, has been subjected physically, morally, and intellectually to the same great law of progress that we trace throughout the system of creation from the Pre-Cambrian epoch to the present time; while if we argue from analogy we must believe in a future history of advancement and of progress." The following evening a conference of colliery proprietors,

mine agents, and members of the Society was held, under the presidency of Mr. W. Matthews, and was numerously attended. Papers were read "On the Working of the Ten-yard Coal;" and "On the Discovery of Cannel Coal in North Wales." We shall refer to these papers presently. It was considered desirable to have a series of elementary lectures on Geology as part of the proceedings at the ordinary monthly meetings; and at the request of the Committee, Mr. H. Beckett, F.G.S., Vice-president, undertook to deliver a course. The first two lectures appear in the 'Transactions;' one, "On the General Principles of Geology;" and the other, "On the Coal Formation." They appear to have been well adapted to their intended object, but we must take exception to Mr. Beckett's chemical geology, especially with regard to his views on the nature, source, and distribution of alumina. Lastly, we notice that five field meetings are announced for the present year, in addition to three others to which dates are not assigned. We may now refer to three of the papers which appear in the 'Transactions.'

The Ten-yard Coal.—As before mentioned, at a conference of mine owners, &c., a paper was read by Mr. Rupert Kettle, Vice-president, "On the Yield of the Ten-yard Coal and the Best Mode of increasing it, having regard to the Safety and Economy of the Working." The method of working this magnificent seam is almost universally that known as "square work," or working by "ribs and pillars." According to Mr. Kettle's calculations, each acre contains 48,400 tons of coal as it lies untouched, whilst the average yield by "square work" may be taken at not more than 24,500 tons, leaving a deficiency of 23,900 tons. To do away with so much of this enormous waste, left partly in pillars and partly as slack, Mr. Kettle strongly urges the adoption of the "long wall" method of working. Here the seam is worked at two different periods, the upper half being first extracted, and after an interval, the lower half. No pillars are left, and the yield is increased according to various estimates from 6,000 to 15,000 tons per acre. In addition to this, it was maintained that the safety to the men in long-wall working is very much greater than by the ordinary method, whilst the ventilation is far more easily rendered efficient.

The Recent Discovery of Cannel Coal in North Wales.—This paper, by Mr. H. Beckett, F.G.S., may be considered as supplementary to the information respecting the Flintshire and Denbighshire coal-field, given by Mr. Hull, in his 'Coal Fields of Great Britain.' That geologist states that "the strata of the Flintshire coal-field rarely attain a great depth, and that the greater portion of the coal, being placed so near the surface, has already been exhausted." When these statements were made, however, and until within a late period, the main coal was the lowest seam generally wrought in Flintshire. At Mr. Beckett's recommendation, Messrs. Jones sank below this seam at Leeswood Green. Here the main coal was 154 ft. from the surface; below it several workable seams of coal were passed through; and at about 93 yards below the main coal, a bed of cannel was reached. This seam, known as the Leeswood Cannel, was four feet

thick. The general direction of the dip of the beds is east, or north-east; but a few hundred yards west of the first shaft a fault of 90 yards occurs, bringing the cannel to within about 35 yards from the surface, and at the same time reversing the dip. The seams of coal between the main coal and the cannel are seven or eight in number, giving a thickness of 16 feet to 24 feet of coal. There are also additional seams below the cannel, and some valuable iron ores. The quality of the cannel is extremely variable. At Leeswood, the roof is a rich "oleaginous" shale. Next below comes the "smooth cannel," which passes down into "curly cannel," so called from its peculiar fracture. According to a report by Dr. Andrew Fyfe, of Aberdeen, the Leeswood Green coals are of excellent quality as gas-producing coals, especially the curly cannel, which may be considered as nearly of the same value as Torbane Hill coals; whilst for coke-producing, it far surpasses the latter. Some of the shales associated with the cannel yield a fair percentage of paraffin. In some places, the cannel is entirely of the "smooth" variety, or is replaced by ordinary bituminous coal. Mr. Beckett considers the Leeswood cannel of Flintshire to correspond with the lower yard coal of Ruabon, in the Denbighshire coal-field, which indeed has recently been met with south of Ruabon as a true cannel, nearly four feet thick. Complete sections of the strata in Flintshire and near Ruabon are appended to the paper.

The Distribution of Organic Remains in the North Staffordshire Coal-field.—This paper, by Mr. John Ward, is highly important. It has been often remarked that whilst we are well acquainted with the fauna and flora of the coal formation as a whole, scarcely anything has been done towards an examination of its constituent beds in any given locality, with the view of ascertaining what species or genera are specially characteristic of its several subdivisions. In the present paper, this object is attempted for the coal-field of North Staffordshire; and more especially that part of it called the Potteries coal-field. The coal measures have been divided by Mr. Smyth into four parts:—1st. The upper measures, consisting of marls and clays down to the top of the Red Mine, 1,000 feet. 2nd. The Pottery coal and ironstone measures, down to the Ash or Rowhurst coal, 1,000 to 1,420 feet. 3rd. Lower thick measures, including the Winpenny and 17 or 18 seams of coal above two feet thick, 1,400 to 2,400 feet. 4th. Lowest measures, including the Wetley and Shafferlong coals, about 800 feet. The upper or 1st division is not rich in fossils, but Anthracomya Phillipsii is abundant. The 2nd or Pottery measures have an extraordinary series of organic remains. About twelve yards above the Bassey mine ironstone is a bed of freshwater limestone, with Spirorbis carbonarius and scales of fish: this seems to correspond with the Ardwick limestone of the Manchester coal-field. The Bassey mine ironstone (Red mine) has an immense number of Anthracomya Phillipsii, with large specimens of Stigmaria. The Gubbin ironstone has Megalichthys Hibberti, Diplodus gibbosus, and spines of Rhizodus Hibberti. Palæoniscus, which is common in other beds, is here rare or absent. The deep mine ironstone is full of beautiful

and complete fish, including several species of Palæoniscus, also Cycloptychius carbonarius, (Hux.), Cælacanthus, Diplodus, Megalichthys, and Ctenoptychius. In the shale of the Bay coal, there are marine fossils, which is remarkable, the seam being in the upper measures. In the lower thick measures, we find that the Ash coal bass contains several species of Palæoniscus, one having characteristic granulated scales; also Rhizodus, Helodus, Clododus, and other fish. The Burnwood ironstone has fine specimens of Anthracomya Adamsii. The ten-foot coal measures have a "mussel bed" formed of the compressed shells of Anthracosia and Anthracoptera. The 4th division, or lowest measures, contain a valuable bed of earthy hæmatite. In many of the shales of this division, there are multitudes of Aviculopecten papyraceus, together with Posidonia, Goniatites, Lingula, and Orthoceras. It appears that amongst the fish, the genera Megalichthys, Palæoniscus, Cœlacanthus, and Platysomus range throughout the whole series forming the coal measures. The paper is followed by detailed descriptions of the principal genera of fish found fossil in the coal-field, and by a carefully drawn-up table of the organic remains of the same series of rocks, both of plants and animals, the species peculiar to each bed being indicated. Very great advantage would result if each of our coal-fields were examined as closely and described as minutely as that of North Staffordshire is in this paper.

The denudation of Rocks in Devonshire.—We have before us two papers by Mr. W. Pengelly, F.R.S., reprinted from the 'Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art.' In the first the author brings under notice the principal proofs of denudation evidenced by the present condition of the rocks of Devonshire. Commencing with the axiom that "all strata are immediately or mediately the offspring of unstratified rocks," he proceeds to show that rocks of organic origin are equally derivative. The limestones and chalk of Devon are due to animal agency; but the carbonate of lime, of which they consist, was extracted from the sea-water, which in turn derived it from the solution, through the agency of thermal and acidulated waters, of rocks or rock detritus which contained it; in other words, by the destruction of earlier rocks. The operation of building up the limestones by the growth of crinoids, shells, and coral reefs, must have required an inconceivable space of time, if the Devonian sea, like the present, contained no more than 3 parts in 100,000 of carbonate of lime. With regard to the original source of lime, it is remarked that the granitic class of rocks is poor in calcareous matter, but those of the augitic or hornblendic group, including Basalt, Dolerite, and Diallage rock, often contain 10 per cent. of lime; it is not improbable, therefore, that there was an early and large destruction of unstratified augitic rocks. The Bovey Tracey lignite is of vegetable origin, but with it are interstratified sands and clays derived from the Dartmoor granite. The whole formation is at least 300 feet in thickness, of which the vegetable matter barely constitutes 45 feet. The crystalline schists of the Start and Bolt, at the southern angle of Devonshire, are metamorphic; the change they have undergone implies the former exist-

ence of overlying beds of great thickness, which subsequently to the change must have been swept away. There was again a further destruction, for the Bigbury Bay outlier of Triassic conglomerate is mainly composed of fragments of the schists. The Dartmoor granites have a similar history. They have been formed under the pressure of overlying masses, and according to some modern views they were formerly in the state of beds, which have therefore been destratified; in this case they must have been derived from previously existing rocks. Denudation also took place during pauses in the process of sedimentation. This is seen not only in the Triassic series, but also in the Devonian limestone near Hope's Nose, Torbay. The limestone is there seen to be composed of two unconformable series: the lower, which includes several interstratified beds of volcanic ash, having been violently contorted and denuded before the deposition of the upper undisturbed beds. The Torbay limestones, however, represent but a small fraction of the Devonian era. The outliers which are found scattered over the county indicate the former extension over a great part of it of the Trias, greensand, and chalk, which have since been almost entirely removed. Thus there are outliers of Trias on the shores of Bideford and Bigbury Bays, and one of greensand near Bideford, forty-three miles from the principal mass of the formation at Blackdown. On some of the greensand hills there are thick accumulations of chalk flints unrounded and untravelled. The chalk which formerly contained them, and which must have been of great thickness, has been quietly removed by the dissolving power of rainwater containing carbonic acid.

The islets fringing the Devonshire coasts are outlying relics of an ancient coast-line. Other proofs of destructive agency are afforded by "terraces of denudation," where the retreating tide leaves a rocky platform instead of a sand or shingle beach; the water having reduced to a plane surface the outcrop of highly-inclined strata. Similar terraces are seen on the summits of limestone hills now inland. Raised beaches occur round the coasts about 30 feet above the sea, usually occupying platforms or terraces in hard rocks. Occasionally slabs of rock are seen to be cemented to the faces of limestone cliffs. These have formerly fallen into fissures, and been there cemented by water containing carbonate of lime. Subsequently the mass of rock lying between the fissure and the sea has been removed by the waves, leaving the blocks in their present position. The Budleigh Salterton beach pebbles offer striking proofs of repeated denudation. The beach extending from Sidmouth to the eastward extremity of the county is almost entirely composed of quartz pebbles derived from a pebble bed near Budleigh Salterton. The pebbles have been recently shown to contain Lower Silurian fossils similar to those occurring in the quartzite beds of Normandy (*see* 'Quart. Jour. Geol. Soc.,' vol. xx. p. 283; Aug. 1864). Mr. Pengelly hence deduces the following series of changes:—1st. The denudation during the Lower Silurian era of pre-Silurian rocks containing quartz, and the deposition of the triturated material. 2nd. The production, by denudation, of a large amount of débris, which was deposited on the arenaceous

beds. 3rd. The metamorphism of the latter into quartzite. 4th. The denudation of the overlying strata. 5th. The denudation of the quartzites during the Triassic period, and the formation of the pebble-bed. 6th. The denudation of the pebble bed during supracretaceous periods, by which much of the ancient gravel of south-eastern Devonshire was produced. 7th. The continued denudation of the pebble-bed to form the modern beach of Budleigh Salterton. The author thinks that the crystalline rocks of the south of Devon and Cornwall, including those of the Bolt and Start, the Dodman district, and Eddystone, may be parts of one great system, from which the Budleigh Salterton pebbles may have been derived.

The Introduction of Cavern Accumulations.—In this paper Mr. Pengelly shows that the caverns of Devonshire may be divided into four classes, respecting the modes in which their contents were introduced. In some instances, at least, the existing contents of caverns were carried in long after the excavation had been completed. The famous Windmill Hill Cavern at Brixham had certainly been twice filled and emptied before the introduction of the mass of materials which was found in it and excavated in 1858. This is proved by the remains of two former stalagmitic floors, one of which formed a kind of ceiling to a cavity which existed when the cavern was examined, and below which was the most recent accumulation of materials.

The first mode in which accumulations are shown to be introduced into caverns is that through vertical openings communicating with the surface. Several caves occurring in the limestone of Oreston were met with from 1816 to 1822, and described by Mr. Whidbey, who failed to detect any such opening. But in 1858, Mr. Pengelly had an opportunity of examining one of the same series, situated, as he believed, along the same original line of fracture. The roof was eight feet thick, and consisted of large angular masses of limestone cemented with carbonate of lime. This was evidently the position of the original fissure, through which the materials of the bone bed had been slowly and gradually introduced. There had been pauses in the operation, as shown by the frequent occurrence of pure white stalagmite separating masses of breccia. The breccia forming the roof might easily be mistaken for ordinary limestone traversed by numerous irregular and coarse veins. Other examples are mentioned of fissures filled from above, and destitute of roof, though containing bones of the ordinary cave animals well preserved. In some instances, as at Daddy's Hole, Torquay, the fissure has been only in part filled up.

Another mode of introduction is by engulphed streams. The Brixham Cavern consists of a series of galleries having the direction of the two systems of joints which pervade the Devonian rocks of the district, but their roof-joints are too close-fitting to allow anything more than water to penetrate. In this case, however, the cavern has four external horizontal entrances, and the mode of introduction is strikingly shown by the fact that every bone and stone lay with its longest axis in the plane of the deposit, or in the precise position which would have been given to it by a running stream, and not by

the sea. It would appear that the water entered through each of the four external openings, and after flowing almost horizontally, was discharged through a highly-inclined shaft within the cavern, the walls of which shaft are polished and scratched as if by the long-continued action of running water charged with detritus. It was also evident that the introduction of material was intermittent, the volume of the stream having been at times so small as to leave parts of the galleries comparatively dry, and so allowing the formation of a cake of stalagmite. Such engulphed streams exist in some caverns at the present day.

The two remaining methods of introduction which are mentioned by the author as probable, are the introduction of accumulations by the sea, and that by occasional land floods; but the instances which seem to support these latter hypotheses are as yet somewhat isolated.

REVIEWS.

KÖLLIKER'S OUTLINES OF THE LOWEST FORMS OF LIFE.*

About 25 years ago Professor C. G. Ehrenberg, of Berlin, discovered and described a new group of living forms of animal and plant life, all of microscopical dimensions, which he called the Infusoria. Their external appearance was delineated with tolerable accuracy in a work published by the discoverer in Berlin, and translated into English by Pritchard, and thus the new types were made known to the scientific world, and became the objects of close investigation amongst Continental observers. This was in reality the foundation stone of micro-zoology and micro-phytology, and as the father and pioneer of microscopical science, the fame of Ehrenberg will abide for ever.

But although the great Prussian naturalist was an indefatigable collector, and delineator of outward forms, he unfortunately possessed but limited anatomical knowledge. The same spirit that induced him to persevere in adding fresh treasures to our microscopical collections was not carried into his investigations of their anatomical and biological characters, but that spirit is, in a perverted shape, manifested in a dogged adherence to his primitive views. Ehrenberg built up a hasty and superficial system of classification, based on features to a great extent imaginary in his microscopical favourites, which has not borne the test of time, and although it has not interfered with his great fame as a pioneer, has yet detracted somewhat from the value of his discoveries.

It has been left, then, to others not so able, perhaps, but certainly less prejudiced, to correct Ehrenberg's errors and develop the science of which, as we have said, he was the founder; and although well known to the students of this branch of science, the names of these observers have not been brought prominently before the reading public. They are Dujardin, Cohn, Stein, Jules Haïme, † Gegenbauer, Claparède, Lachmann, Lieberkühn, Engelmann, and in quite recent times, Balbiani, of Paris, along with a few more, chiefly Continental observers. By these gentlemen, the true nature of the "Infusoria" has

* 'Icones Histiologicae, oder Atlas der vergleichenden Gewebelehre,' herausgegeben von A. Kölliker, Professor der Anatomie in Würzburg. Erste Abtheilung. 'Der feinere Bau der Protozoen.' Mit 9 Tafeln und 15 Holzschnitten. Leipzig, Wilhelm Engelmann. ('Histological Sketches; or, an Atlas of Comparative Histology,' by A. Kölliker, Professor of Anatomy at Würzburg. Part I. 'The Minute Structure of the Protozoa,' with 9 Plates and 15 Woodcuts. 4to. Leipzig: Engelmann.)

† Whose name is unaccountably omitted by the author, although, if we recollect rightly, he was one of the first to contribute valuable knowledge on this subject, in the pages of Kölliker's own journal.

been to a great extent defined, and systematic zoologists have been able, in some degree, to arrange and classify them in the various groups to which they belong. As to the phases through which the history of the true Infusoria has passed, these are easily summed up. Ehrenberg considered (and we believe still considers) them to be microscopical animalculæ of comparatively high organization; and the error he committed was to seek and imagine that he had found in them a structure identical with that of the higher animals. That they *are* to a certain extent so endowed is quite true, but whilst he overlooked or failed to trace the homologous features which actually exist, he invested them with others which they do not possess, and wherein they are in reality rather allied to plants than to animals. Thus he ascribed to them a mouth, throat, numerous true stomachs in which he and his disciple Pouchet professed to see distinct membranes (hence Ehrenberg's term Polygastrica), and a connecting intestinal canal; also a heart, true circulation, and a "nucleus" or germ, with a "nucleolus" or germinal vesicle. Their method of reproduction he believed to be similar to that of plants, by subdivision, and gemmæ or buds. It may be briefly stated that although he was to a certain extent correct in his observations concerning the multiplication of these forms, yet, as will be shown presently, it is precisely here that they are most closely linked to the animal kingdom, whilst his imaginary stomachs ally them rather to some of the lowest forms of plant life.

In the course of time, and after a somewhat acrimonious contest, the opponents of Ehrenberg succeeded in sweeping away his whole anatomical system, and Dujardin degraded the infusoria to the position of unicellular animalculæ, formed of a substance which he called "sarcode," almost void of organic structure, but possessing the power to ingest food through an oral aperture, that food collecting in "vacuoles," or improvised globules (the stomachs of Ehrenberg), and rotating in or with the sarcode, somewhat after the manner of the semi-gelatinous "protoplasm" in certain lowly algæ. Other observers compared the "heart" or "contractile vesicle" to the "vascular water system" of certain "vermes," and the "blood" was believed to be a liquid admitted from without, rather than a true circulating fluid, the result of digestion. Thus, if we may be permitted to indulge in a passing joke, the poor little infusoria were made to look smaller than they really are; but they were reserved for a higher destiny, chiefly in consequence of the able researches of Dr. Balbiani of Paris, to whom reference has often been made in these pages; it will be found from the work under review, although they are placed by the author below three other groups of Protozoa, that they are really possessed of a tolerably well-developed animal organization.

The "polygastric" system of Ehrenberg has, it is true, disappeared for ever, and the alimentary apparatus consists of an oral aperture or mouth, a gullet, which the author believes to be in all cases contractile, temporary digestive vesicles which rotate within the unicellular animalcule, a contractile vesicle of the nature of a heart; a circulating system of minor vesicles, an anal aperture for the discharge of exhausted alimentary substances. Of the "circulating apparatus,"

we may say in passing, that we believe even Professor Kölliker under-estimates the extent of its development, for from personal observation we feel satisfied that in many of the larger and more active Infusoria, it foreshadows through a recurring, if not constant, system of accessory canals, the circulating apparatus of the planarian worms and of other animals ranking higher in the scale. The feature, however, in the Infusoria which has wrought the most important change in their zoological value is the reproductive apparatus, for it is clearly shown in accordance with the researches of Dr. Balbiani that they are provided with the essential elements which distinguish the sexes, and that they follow, in this respect, the great developmental law prevailing throughout the animal realm.

When it is remembered that the forms here treated of vary from $\frac{1}{80}$th down to $\frac{1}{1000}$th of an inch in length, it must be conceded that they are highly organized, and it may be added also that they possess active locomotive powers, and that although no trace of a nervous system has yet been discovered, it is highly probable that they have the capacity of selecting food, and (according to many observers, including the author) are endowed with a will, however limited in this instance may be the acceptation of the term.

Below the Infusoria Professor Kölliker places one other group of animalculæ, namely, the *Gregarinidæ*, microscopical parasites often found in the lower types of aquatic worms, and *Entomostraca*, which are still more obscure in their structure and development than the Infusoria; and next in order above the last named are what he terms the *Rhizopoda* proper, including the well-known *Actinophrys sol*, the *Globigerinæ*, and *Foraminifera*. The last two are the best known of the Protozoa in England, for they have been made the subjects of special study by our English microscopists, and the chief authorities are Dr. Carpenter, Professor Williamson, G. C. Wallich,* H. J. Carter, and Dr. Strethill Wright.

Little is, however, known of the physiological nature of this group, their beautiful many-chambered shells being their chief attraction, and we are induced to pass them by for the purpose of introducing our readers to the one placed next above them by the author, namely, the *Radiolariæ*, which have not yet, as far as we know, been systematically described in the English language, and are but little known even to the initiated in Microscopical Science. Indeed, it is only necessary to state that although the author of the work before us describes with great minuteness thirteen distinct genera and several species, there is no mention of any one of them, nor of the group itself, in the second edition of the 'Micrographic Dictionary,' in order to show that they are all recently discovered types.

And what exquisite forms do these Radiolariæ exhibit! We feel sure that their beautiful shapes have only to be seen by our microscopists, to make them forget Diatoms and Desmidiæ in their anxiety to possess them; for, along with the beautiful cases of these they com-

* See his paper No. I. 'Quarterly Journal of Science,' and Figs. 1–6 in the Plate appended to the paper.

bine all the attractions of living and moving beings, and their interest is by no means confined to their external coverings. Some of them resemble globular groups of pearls, with a brilliant central gem of more solid consistency, the whole emitting bright rays (*pseudopodia*) in every direction; and on examining the constituent globules, each one is found to be more or less highly organized. Others are still more beautiful and interesting; one, for example, resembles a conical Japanese hat of honeycombed silex, bristling all round the rim and on the apex with spikes, and harbouring in the crown of the silicious fabric the multicellular animalcule, from which innumerable rays are projected. Another is a perfect hollow silicious sphere of filagree, also honeycombed, and in the centre floats a beautiful sun, whose rays penetrate the open framework of the globular case; and a fourth, more exquisite perhaps than any of the preceding, might serve as one of the insignia of some noble order, for it presents the appearance of a jewelled star. The central portion is the hyaline animalcule resembling a globular pearl in appearance, from which project silicious rays, some lance-shaped, others straight, and all meeting within the central globe. There are many more such forms, varying in the shape of the central soft portions, or in that of the radiating silicious skeleton, or of the surrounding casework, but all are more or less graceful and elegant, and the delineations of them in the present work have only to be seen to render them eager objects of search and favourite subjects for investigation.

Little seems yet to be known of the physiological attributes of the Radiolariæ, and for what has been revealed in this respect, the student will find himself indebted to Ehrenberg, T. H. Huxley, J. Müller, Claparède and Lachmann, A. Schneider and E. Häckel. An account of the minute anatomy of the sponges concludes this work on the Protozoa; and these are described with great clearness, justice being rendered to all observers who have contributed to our knowledge of their Natural History.

The opinions of Professor Kölliker on all matters connected with microscopic anatomy and micro-zoology, are entitled to great consideration, and it will be interesting to some of our readers to hear his opinions on two or three debated topics. After carefully reviewing the question of the distinctive characters of the lowest plants and animals, he comes to the conclusion that there is no well-defined distinction between them. Again, both as bearing upon this question, and as a matter of interest to psychologists, it may be mentioned that he believes the Infusoria to possess a will, for in describing how the cilia of *Paramecium bursaria* may be excited to movement by the action of acetic acid after they are separated from the body, he says, this shows that although these organs are generally under the controul of the animal's will, they are not *necessarily* so ("was zugleich zeigt dass diese Organe wenn auch gewöhnlich, doch nicht nothwendig unter dem Willeneinflusse des ganzen Organismus stehen."—p. 10).

As the author cites the presence of Cilia in the lowest plants, as well as the lowest animals, as part of the evidence to prove that it is impossible to distinguish one from the other, we have the choice

between believing that the motile ciliated unicellular plants are endowed with a will; or that a will is one of the characteristic attributes of animals only, from the highest to the lowest. It is not our intention further to discuss the subject here, it only shows how interesting is the study of these lowly forms of life. The author believes that the Infusoria are provided with urticating organs somewhat similar to those of the Hydro-Medusæ, and he describes them with great minuteness. The sponges, he considers, possess the first approach to muscular fibre, and for this reason, amongst others, he places them at the head of the class Protozoa. His observations lead him to believe that he has found Spermatozoa in sponges; the reader will, however, be disposed to agree with him that further investigations are needed to confirm the fact. Finally, he explains the method in which he believes the beautiful sponge spicules to be produced; having discovered in many of them a central core, which he says he has seen protruding beyond the barrel of the spicule, and which, he thinks, forms the nucleus that serves as the basis of its development.

In directing the notice of our English microscopists to this beautiful work of Professor Kölliker, by far the best handbook of the Protozoa extant (if its shape will admit of its being called a handbook), we cannot help regretting that more attention has not been paid in England to the forms of which it treats. It is true that the history of the Foraminifera, and to some extent that of the sponges, are the fruits of British intellect, but the commonest types of Protozoa, and those most easily accessible, have been sadly neglected by our biologists, whom we should be glad to see rank side by side with Continental observers in this branch of Zoological science. The investigation of these forms will throw fresh light upon the whole question of species. Do any of our investigators fear to approach the subject, lest the results should "unsettle" their minds? If so, it will always be left to foreign microscopists, who are less impressible in that respect.

The present work, which presents, as we have already said, by far the most complete epitome of the anatomy and physiology of the Protozoa, forms the first of a series, which is to embrace the whole animal kingdom, and the well-known labours of the author leave little doubt that the remaining portions of his task will be executed with equal ability. We presume that arrangements will be made to translate each section of the publication as it appears; meanwhile such of our readers as are able to study it in the original tongue will do well to possess themselves of what promises to be an invaluable series of "Histological Sketches."

THE LIFE OF THE SECOND MARQUIS OF WORCESTER.*

The work before us is of a twofold character; it possesses interest both for the historian and for the man of science, and it is difficult to decide in which direction the preponderance of interest lies. In the first half of the work the author has given a history of the life and times of the second Marquis of Worcester, illustrated by a number of private letters (now printed for the first time), which throw much light on the political history of England, during the civil wars of the time of Charles I., and further gives us some insight into the manners, customs, and the tone of thought which prevailed at this period. Next follows a reprint of the celebrated 'Century of Inventions,' upon which the scientific fame of the Marquis is entirely founded; this is annotated with great care by the author, and is of special interest to those who study the history of science.

The period comprised within the life of the Marquis was one of the most eventful in the annals of England. The accession of the House of Stuart in the person of a king of weak and vacillating character, possessing most extravagant notions of his own prerogative, delighting in flattery, easily swayed by favourites, pedantic, most vain of his learning; in every way unsuited for exercising the powers of a king: the succession of his son, who possessed many of his own traits of character, was more vacillating perhaps, undoubtedly less sincere, and more determined to uphold the divine right of kings; the gradually increasing power of the Commons; the rupture between the King and the Parliament; the civil wars; the final dominance of the democracy, and the violation of all kingly rights; the temporary subversion of the monarchical government; the Restoration—all this occurred during the lifetime of the Marquis. Let us turn to revolutions of another kind. The mode of scientific thought, the manner of interrogating nature, was changed during this same period: the physical philosophy of Aristotle, which had obtained for 2,000 years, was supplanted by that of Francis Bacon; but no rights were violated here, the old philosophic dynasty had long been falling into disrepute, and latterly had retained its sway by force alone; its downfall was hailed with joy; the new dynasty was welcomed by all, and recommended itself to all; it came quietly and peaceably, for its founder had forbidden that force should be resorted to for its establishment.† A new light had dawned on the human intellect, a fresh impulse had been given to it, and hereafter it was to flow in hitherto unknown channels. The change was going on before

* 'The Life, Times, and Scientific Labours of the Second Marquis of Worcester; to which is added a reprint of his "Century of Inventions."' By Henry Dircks, C.E. London: Bernard Quaritch. 1865.

† "Dixit Borgia de Expeditione Gallorum in Italiam, eos venisse cum cretâ in manibus ut diversoria notarent, non cum armis ut perrumperent; itidem et nostra ratio est, ut doctrina nostra animos idoneos et capaces subintret; confutationem enim nullus est usus, ubi de principiis ut ipsis notionibus, atque etiam de formis demonstrationem dissentimus."—*Novum Organum*, lib. i., aph. 35.

the eyes of the Marquis, he saw the last impotent efforts of his Church to curb the free workings of the human mind; he witnessed the birth of the new philosophy, the publication of the 'De Augmentis,' and later, that of the work which in all after ages was to direct the philosophic mind,—the 'Novum Organum.' But we question if he ever read this latter work: he certainly did not act up to its precepts; the 'Century' is not the work of a Baconian philosopher. We regret, moreover, that Bacon is scarcely mentioned in the book before us, for we conceive that no work which treats of the science of the first half of the 17th century can be at all complete without much mention of him; but we do not think that Mr. Dircks is imbued with the spirit of the Baconian method:—"All invention," he writes, "is progressive—first, laws of Nature are discovered; then, applications are invented; and last, follow divisions, and subdivisions of endless great, small, and minute improvements." We submit that the views inculcated in this sentence, are entirely opposed to the true spirit of inductive philosophy, as well as to the experience gained from past ages; throughout the history of science we find that laws of nature have been deduced from applications of them, not the reverse. The pump was invented ages before anything was known of the pressure of the air; the steam-engine long before the properties of condensable vapours had been studied.

Edward, second Marquis of Worcester, was born in 1601; he was the son of Henry Somerset, Lord Herbert, who was created Marquis of Worcester by Charles I., in 1642. We hear but little of the second Marquis till the breaking out of the civil war in 1640. As a young man he had a taste for mathematical and mechanical studies, and undoubtedly spent much time in putting in practice various schemes, and in making models of different mechanical devices. Shortly after his marriage in 1628, he engaged the services of a foreign engineer, named Caspar Kaltoff, whom he appears to have retained permanently in his employ; in the dedication to the 'Century' (published in 1663) he speaks of him as having "been these five-and-thirty years, as in a school under me employed." The Marquis and his father were most devoted to Charles I., and on the commencement of the civil war they warmly joined his cause. In 1640 a commission was granted to the Marquis empowering him to levy forces in several counties in England and Wales, and in 1642 he was appointed general of South Wales, a number of troops raised by his father being placed under his command. Nor did the Marquis assist the cause of the King by services alone, he advanced large sums of money, and repeatedly levied forces at his own expense. At a later date, in a petition presented to Charles II., he estimates the money "that I have spent, lent (and lost?) for my King and country," at 918,000*l*. In 1645 he was sent to Ireland by Charles I., with orders to conclude a peace with the disaffected party by granting some important concessions to the Roman Catholics, on the condition that they should send 10,000 troops to England for the King's service; but the object of his visit was discovered, and in 1646 he underwent an examination before the Lord Lieutenant and the Council of Ireland, which

led to his imprisonment in Dublin Castle; he was shortly afterwards released on bail. Charles denied all cognizance of the matter of the treaty, and some have affirmed that the Marquis was guilty of forgery; it has been satisfactorily proved, however, that he was commissioned by the King to treat with the Catholics; at the same time, while we think that Charles is to be chiefly blamed, we cannot entirely exonerate the Marquis. In 1648 he quitted Ireland, and passed over to France, where he remained in exile till 1651, when he returned to England to privately ascertain the feeling which prevailed relative to the return of Charles II.; he was discovered, however, and imprisoned in the Tower in 1652, but was released on bail in 1654. In the following year the Marquis wrote his 'Century of Inventions.' At this time he was in great pecuniary distress, his castle in Monmouthshire had been destroyed by the Parliamentarians, his estates had been confiscated, and his money had been devoted to the late King's service; in 1655 Cromwell allowed him three pounds a week for his better maintenance. At the Restoration he might with justice have hoped for a return of at least a part of his loan to the late King, but it was otherwise, for although he constantly petitioned both the King and the Parliament, little notice appears to have been taken of his requests, except to return him his heavily encumbered estates, and to grant him a monopoly of an engine for raising water by steam which he had recently invented. It must be allowed that Charles ill-rewarded one of the most loyal of his father's subjects, one who had sacrificed all for his King. The Marquis died in London, and was buried at Raglan, in Monmouthshire, on April 17, 1667.

The 'Century of Inventions' was written in 1655, and was first printed in 1663; a MS. copy (not the original, which does not exist) is preserved in the Harleian Collection. The 'Century' gives the titles alone of a number of inventions, or rather improvements on former inventions; at its conclusion the Marquis promises "to leave to posterity a Booke wherein under each of these heads, the meanes to putt in execution, and visible tryall, all and every of these Inventions, with ye shape and forme of all things belonging to them, shall be printed by brasse plates;" it is much to be regretted that this was never done, for from the obscurity of the language employed in the 'Century,' it is impossible to surmise the exact nature of any one of the inventions mentioned therein. This work has been reprinted no less than twenty-three times; for the completeness and extent of its annotations we believe this to be the most valuable reprint which has appeared; Mr. Dircks has carefully traced the early history of most of the inventions alluded to, and for this he is entitled to the thanks of scientific men:—we consider that these annotations constitute some of the most valuable parts of the work.

We will very briefly consider the nature of the various inventions, the titles of which are given in the 'Century.'

The first and second inventions relate to seals of different kinds, capable of showing the day of the week, the date in full, the names of witnesses, the name of any one of ten thousand places at which a document may be sealed, the number of lines contained in a docu-

ment, and other matters of importance in connection with the signing and sealing of contracts.

Inventions 3 to 5, 33 to 43, 51, and 75 relate to secret correspondence. Writing in cipher was much practised during the sixteenth and seventeenth centuries, and we can understand why this was the case when we remember the instability of the times, the absence of all postal regulations, and the consequent necessity of sending letters by messengers, who were constantly exposed to the attacks of highwaymen. Several works relating to different modes of secret correspondence were printed during the 16th century; Francis Bacon ('De Augmentis,' lib. vi. cap. 1) describes at length a cipher which he invented when a young man. Many of the letters of Charles I., written during the period of the civil war, are in cipher, as also are some of the letters of the Marquis to the King.

Inventions 81 and 82 relate to the conveyance of letters secretly by concealment in a comb, and in the handle of a knife, fork, or spoon.

Invention 32 treats of a universal character intelligible in any language.

Invention 76 is entitled, "How to write in the dark as straight as by day, or candle light." Mr. Dircks suggests that this might be effected by writing on a ground-glass box lid illuminated from beneath.

Inventions 6, 7, and 52, refer to telegraphy. The first telegraph was invented by Æneas Tacticus, and was for the purpose of enabling two armies acting in concert to communicate with each other at a distance: one or two other forms were invented in the age immediately preceding that of the Marquis, but we have no record of how they were worked. The 52nd invention ("How to signify words and a perfect discourse by jangling of bells of any parish church") brings to our mind Sir Charles Bright's recently-invented bell-telegraph, an instrument of such efficacy that forty words may be transmitted in a minute: the bells are struck by weighted magnetic needles.

Inventions 9 to 15, 65, 93, and 96 relate to naval affairs, chiefly in connection with naval warfare. In the annotations to the 15th invention ("A way how to make a boat work itself against wind and tide"), Mr. Dircks has given an interesting historical account of the introduction of paddle-wheels, from which we learn that in an Italian MS., attributed to the fifteenth century, a sketch is given of a boat furnished with two paddle-wheels, fixed on a large vertical wheel, turned by the hand. Further, in 1521, an engraving was published of a vessel provided with paddles, worked by animal power; and again, in 1574, 1578, and 1651 we have notice of similar schemes, so that the Marquis had abundance of previous matter to help him.

Inventions 8, 24, 28 to 31, 44, 49, 50, 58 to 64, 66 to 68, 73, 80, 94, and 95 refer to gunnery, the construction of fortifications, and other matters relative to military affairs. As prominent among these we may mention a "key pistol," which may be used either for unlocking a door, or for piercing a breastplate, as occasion may require; a method of causing a pistol to discharge a dozen times with one loading; a ready way of loading musketoons on horseback; and a method of rapidly constructing a cannon-proof fortification.

Inventions 20 to 22, 53 to 55, and 57 relate to hydraulics.

Inventions 23, 47, and 78 relate to horology. In 23 a water-clock is mentioned, which shows hours, minutes, and seconds; also the motions of the heavenly bodies, and of the earth, according to the Copernican system; not many years before Galileo had been imprisoned by the Inquisition for daring to promulgate the Copernican theory, it is therefore with pleasure that we find the Marquis (a Catholic) embracing a theory the propagation of which his Church had endeavoured to suppress; it is a sign of the rapidly decreasing power of the hierarchy which had so long ruled supreme. In 47, we have the description of a metal ball, which, when thrown into water, floats in such a manner as to indicate the exact minute of time. The 78th invention treats of a watch which does not require winding, but must be consulted occasionally. The commentator suggests that it was probably so contrived that by opening its case to see the time, it was wound up. The clocks of this period were very inaccurate; a few years after the publication of the 'Century,' Robert Hooke introduced the circular pendulum and other improvements, which greatly increased the accuracy of horological instruments; Huyghens also contributed much in this direction.

We may mention together the following miscellaneous inventions, which cannot be classed under any special head:—(56) a contrivance for producing perpetual motion; (84) a machine, by means of which persons ignorant of arithmetic may effect numerical calculations; (97) an instrument, by which an unskilful person may take the perspective of anything; (19) a contrivance for disengaging run-away horses from a coach. This was patented by the Marquis in 1661; if we remember rightly, a patent having the same object was taken out in England about three years ago. (45) a means of lighting a candle readily at any time of the night without rising or putting one's hands out of bed. The commentator mentions that it is stated in a work published in 1661, that one Caravagio, of Sienna, constructed a clock which would awake a man at any hour he pleased, and at the same time strike a light by flint and steel. We observed the other day, in the Dublin Exhibition, a small clock of German manufacture, described as "An alarum, lighting a candle when striking." (74) a door, which by the motion of its handle may be made to open either inwards or outwards; (48) a screw-like ascent, to be substituted for stairs; (83) a mill for rasping hartshorn; (87) a mould for casting candles.

Invention 17 relates to a garden to be floated on the Thames, and to contain trees, fountains, bathing-places, banqueting houses, and mills for producing music; the commentator adds, "The whole offers one of those raree-show designs in which our great-grandfathers delighted, and the descriptions of which formed the staple of their scientific discussions in polite society." We do not agree with Mr. Dircks here, for shows of this description were more in vogue in the time of Henry VIII. and of Elizabeth than in that of Charles I., and we cannot think that *scientific* discussion was ever wasted on such subjects at any period, certainly not so late as the age of Bacon and his immediate successors.

Inventions 69 to 72 and 79 relate to locks and keys. The lock mentioned in 72 is so constructed that the way of opening it may be varied ten millions of times by the owner; moreover, if a stranger attempts to unlock it, an alarum is set going, and his hand is simultaneously caught in a trap; the lock also shows how much money has been extracted from the box to which it is affixed, and how often it has been opened since the owner last opened it: the latter part of this description unfortunately annuls the former, for it shows that the lock, in spite of all its advantages, can be opened by others than the owner.

We have next to mention various automata, which remind us greatly of some of those described by Hero, of Alexandria. First (18), we have an artificial fountain capable of producing ice, snow, thunder, and the chirping and singing of birds; next (46), comes the mention of an artificial bird which may be made to fly; 77 is entitled "How to make a man fly; which I have tried with a little boy of ten years old in a barn, from one end to the other, on a hay mow." From the time of Dædalus men have attempted to fly; not two months ago we read an account of a Frenchman who had succeeded in constructing wings which enabled him to fly a short distance; Roger Bacon believed in the possibility of flying; Hooke employed his fine mind for a length of time in endeavouring to devise modes of flying; indeed, the intellect wasted on this futile search, might, if directed into other channels, have produced gigantic results. Invention 88 relates to a brazen head, into the ear of which if a man whispers, he receives an answer from the mouth of the figure in French, Latin, Welsh, Irish, or English; this was by no means the first talking automaton—Roger Bacon, Albertus Magnus, William Bourne, and Bishop Wilkins had each constructed a similar device.

Inventions 85 and 86 relate to instruments of torture: the one, a chair which imprisons those who sit in it; the other, "A little ball made in ye shape of a plum or peare, which being dexterously conveyed or forced into a bodyes mouth shall presently shoote forth such and soe many bolts of each sydes, and both ends, as that without ye owners key can neither bee opened, nor fyl'd of, being of tempered steele, and as effectually locked as an iron chest." "It is difficult," writes Mr. Dircks, "to understand the intended use of this instrument, but it is more likely to have been suggested from a feeling of humanity than from any other motive. A desperate and ferocious enemy thus rendered helpless before being manacled would, assuredly, be less dangerous than he could otherwise be considered; and it would not therefore be requisite to take his life for personal safety; once thus secured he would be likely to listen to any terms of mercy." We entirely agree with the opinion expressed in this last sentence, but we cannot receive the explanation given of the intended object of this invention. Mr. Dirck's hero can apply his intellect to no ignoble purpose: "*a feeling of humanity*," we call this a relic of Middle-Age barbarity; an instrument to be classed with the rack, the thumb-screw, and the spiked collar, worthy to have been used in the darkest and most gross period of the Spanish Inquisition; we think, moreover,

that its invention or improvement in the 17th century, was an act unworthy of even a mediocre intellect.

Close upon this follow two inventions (89 and 90) which, in spite of what the commentator says on the subject, we can call neither more nor less than devices to enable one to cheat at cards and dice. The first is a mode of knotting silk in a pair of gloves in such a manner that "without suspicion," reckoning may be kept of all sixes, sevens, and aces, which a player at primero (an old game of cards) may have played. The second relates to a dice-box from which four false dice may be thrown out, while the real ones are at the same time fastened to the inside of the box.

Invention 26 relates to the raising of weights by leverage according to a method which the Marquis had seen in use in the Arsenal at Venice. Inventions 25, 27, and 99, refer to the raising or moving of a great weight through a certain space, by means of a small weight moving through an equal space. The commentator explains this by supposing the small weight to be represented by a piston moving air-tight in a cylinder, and that the great weight is moved by atmospheric pressure on the upper surface of the piston, a vacuum having previously been produced, by condensing steam beneath it. The explanation is ingenious, but we think far-fetched, for we have no reason whatever to suppose that the Marquis discovered the atmospheric engine.

We come now to the greatest of the inventions of the Marquis, the invention so often alluded to throughout this work; had all his other inventions been destroyed, this, according to his admiring biographer, would alone have rendered him immortal—we allude to the application of steam to the raising of water on a large scale. Inventions 68, 98, and 100 relate to this "water-commanding engine." We are bound to say that if the Marquis had invented and perfected the steam-engine as it now exists, he could not have spoken of his invention in higher terms: "I may boldly call it," he writes, "the *most stupendious work in the whole world;*" again he speaks of it as a "semi-omnipotent engine;" the introduction of *semi* we consider a great piece of modesty, when we compare the sentence with others on the same subject; "By Divine providence," he writes, "and heavenly inspiration, this is my stupendious water-commanding engine, boundless for height and quantity." In common with the other inventions mentioned in the 'Century,' this is described in very obscure language: it is defined as "an admirable and most forcible way to drive up water by fire, not by drawing or sucking it upwards, for that must be, as the philosopher calleth it, "intra sphæram activitatis, which is but such a distance . . . I have seen the water run like a constant fountain stream forty foot high; one vessel of water, rarefied by fire, driveth up forty of cold water, and a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim between the necessity of turning the said cocks."

The first application of steam as a motive power is mentioned by Hero of Alexandria, in his "Πνευματικα." A hollow sphere of metal, capable of free revolution, is furnished with two tubes, which issue from opposite points of its circumference, and are bent near their free extremity at a right angle; the sphere is partially filled with water, and heated; the steam issuing from the extremity of the tubes causes the sphere to revolve, on the principle of Barker's mill. Small working models of Hero's engine are to be seen in the windows of instrument makers; and an engine of this form has been patented, and is occasionally used, in the present day. From the time of Hero we hear nothing more of the application of steam till the beginning of the seventeenth century. In a work published about 1600, Hero's engine is recommended to be used for turning spits, its great advantage being that the partakers of the roasted meat may feel confident "that the haunch has not been pawed by the turnspit (in the absence of the housewife's eye), for the pleasure of licking his unclean fingers."

Hero mentions several devices for producing a fountain by means of compressed air. The apparatus he describes is exactly similar in construction to the compressed air fountain of the present day: a metallic vessel is provided with a tube, which reaches nearly to the bottom of it, and is terminated above by a jet capable of being opened or closed at pleasure. The vessel is partially filled with water, air is then condensed into it by a syringe; on opening the jet, water is forcibly ejected by the condensed air. In 1615, Solomon de Caus, a French engineer, describes and figures a fountain similar in form to that of Hero, but worked by steam instead of by condensed air. He writes as follows:—"Le troisième moyen de faire monter est par l'aide du feu, dont il se peut faire diverses machines; j'en donneray ici la démonstration d'une;" from which it would appear that this was not the first application of steam to the raising of water, although it is always quoted as such. We conceive that but little merit is due to De Caus, if indeed he devised this slight modification of Hero's fountain, which we think improbable. From the time of Hero (and probably long before), a jet of steam was employed in the place of ordinary bellows for blowing fires, water-air could, therefore, take the place of other air (indeed, it was generally believed that all airs were the same), what, then, could be simpler than to extend that replacement in other directions?

In 1628, Giovanni Branca, an Italian mathematician, produced rotatory motion by causing a jet of steam to impinge against the vanes of a wheel; the amount of motive power must have been very small.

We believe John Rey, a physician of Bugue, was the first to raise a piston by steam; in a work published in 1630, he describes a method for determining the volume of air produced from a known volume of water; for this purpose, he procured a hollow metallic cylinder, open at one end, and closed at the other, with the exception of an orifice, into which the beak of a small elopile could be fitted air-tight; a piston was forced down to the bottom of the cylinder, the elopile, full of water, was then fitted into its place, the water within

it converted into steam, and the height to which the piston was raised carefully noted; by comparing the capacity of the cylinder below the piston with that of the elopile, the volume of air produced from a known volume of water could be readily calculated.

In 1630, a patent was granted to one David Ramsay, for an invention capable of being applied "to raise water from low pits by fire;" unfortunately, no description has been left of the invention.

We come now to the engine of the Marquis of Worcester, which appears (as far as one can judge from his very meagre and obscure description), to have raised water by a means similar to that employed by De Caus, *viz.* by the pressure of steam on the surface of water; but the Marquis had two water vessels, and perhaps a separate boiler for generating the steam employed: moreover, he obtained continuous action, and could raise large volumes of water. To him, therefore, belongs the merit of first applying steam to practical purposes on a large scale. Mr. Dircks has written much to prove that Savery's engine for raising water (a model of which was exhibited before the Royal Society in 1698) was the same as that of the Marquis; but we think he has pressed the point too far, for the Marquis, as we have seen above, expressly states that his engine raises water "not by drawing or sucking it upwards," whereas Savery raised water the first 30 feet by atmospheric pressure (the vacuum being produced by the condensation of steam), and then forced it higher by the pressure of steam. We do not think the engine of the Marquis was a perfect success, or it would have been more generally employed during the period intervening between its invention and the introduction of Savery's engine.

Mr. Dircks consummates all he has said of the 'Century of Inventions,' in the following sentence:—"The 'Century' stands alone in the languages of the civilized world, the strange monument of a strong mind, seeking its full development in a prejudiced age, striking into new paths which society could not comprehend, and which it therefore would not patronize." We would remind Mr. Dircks that in the 17th century it was not customary to describe scientific discoveries in obscure and unintelligible language; it was necessary to do so during the Middle Ages, when every kind of rank superstition was dominant, when a man who made a great discovery was believed to be in communication with the powers of darkness, and ran the risk of excommunication, or of being burned as a wizard, but there was no need for it now. The 'Century' is far more obscure than the "Πνευματικα" of Hero, published 1800 years earlier; it is more obscure than Porta's 'Magiæ Naturalis' (both of which works it resembles in certain respects): we know of no scientific work published in the 17th century of like obscurity, it reminds us most forcibly of some of the less intelligible of the writings of Roger Bacon. Compare it with the 'Sylva Sylvarum,' or, better, with the writings of Boyle and Hooke, and the contrast becomes striking: it would be unjust to compare it, either for its diction or for the inventions described in it, with the 'Micrographia;' the author of the latter work we do not hesitate to affirm did more to benefit the human race than the Mar-

quis. He was a contemporary writer, a brother inventor, but his writings lack the obscurity and the bombast of those of the Marquis, and it cannot be denied that Hooke was the greater philosopher, and the greater mechanical genius of the two.

We cannot regard the Marquis of Worcester as "one of the most extraordinary mechanical geniuses of the 17th or any preceding century," as possessing "a mighty intellect," or the other exalted mental attributes with which Mr. Dircks endows him. How has the world profited by his labours, what benefits has it reaped from the 50,000*l.* which he declared he spent "in trying experiments and conclusions of art?" He was a schemer rather than an experimental philosopher. To take the subjects mentioned in the 'Century,' how many are utterly unworthy the attention of a great intellect, how many are perfectly useless! Moreover, they are, for the most part, not original inventions; we have previous mention of almost everything to which he alludes, and we can at most call them improvements upon, or modifications of, older inventions. The Marquis was not an original thinker, he worked up old ideas: had he written of the importance of his inventions with less bombast, we might have given him credit for knowing more than we can now do; as it is, we can but think that he often exaggerates, and strives to mystify and excite the wonderment of the world, rather than to describe inventions of utility to his fellow-men.

THE CONSTRUCTION AND USE OF THE ACHROMATIC MICROSCOPE.

The title of this work * introduces it to the reader as an advertisement of Messrs. Smith and Beck's Microscopes, and there is no attempt whatever on the part of the author, a gentleman of considerable merit as a microscopist, to disguise the fact that it *is* an advertisement. If this had been all we have to say either for or against the book, it would have been left unsaid, for we have no wish to give undue prominence to the instruments, excellent though they be, of any particular manufacturer, to the detriment of any other, and whilst we are quite willing to accord due praise to Messrs. Smith and Beck for their efforts to improve the microscope, we cannot forget that Mr. Ross, Messrs. Powell and Lealand, Mr. Cooke, Mr. Pillischer, Messrs. Crouch, Mr. Collins, Mr. Ladd, and many others known to fame, are all making laudable exertions to improve and popularize the beautiful instrument, and all with marked success. But whilst we mention that Mr. Beck's book is published to advertise his instruments, and to explain their use and mechanism to those who may not be fully initiated in their employment, we have to deal with it also as a legitimate treatise on the microscope, for it is a work that will be found useful not only to those who possess an instrument made by the author's firm, but to every microscopist. It describes concisely, and,

* 'A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscopes.' By Richard Beck. Van Voorst, 1865.

as it may be well supposed, accurately, the various parts of the instrument; gives excellent directions for practising different methods of illumination, by natural and artificial light; with the aid of the parabolic condenser and the "Lieberkuhn;" and describes the various forms, and the modes of employing the polariscope. The Binocular microscope, too, is treated at some length, and illustrations are given to exhibit its superiority over the simpler form of the instrument. The auxiliary appliances, such as the camera lucida, live-boxes, compressors, micrometers, lamps, dissecting instruments, mounting apparatus, &c. &c., are all described, and the whole subject is fully illustrated, so as to render any misunderstanding impossible.

As for the illustrations, they are unique. The text occupies 134 pages, and the work contains 76 woodcuts and 27 plates, many of them well executed by the author himself, and all of the first order; some of the delineations of illuminated test-objects and polarized specimens equal in artistic beauty anything of the kind that we have seen.

Regarded as a treatise on the microscope and its uses, the work is, however, far from being complete, and we are sorry to perceive that the author has ministered so largely to the popular, and perhaps fascinating taste for diatom hunting. No doubt those organisms, "diatoms" and "desmids," form very suitable test-objects, and display the powers of a microscope to great advantage, but they create rather a love of display on the part of the owners of a good instrument than a desire to turn it to practical account, and we confess that we shall welcome the day when the *furore* for collecting diatoms has passed over. Then, when scores of amateurs have put their instruments (we had almost said their "playthings") on the shelf, medical men, chemists, physiologists, and micro-geologists, will be found to be the true patrons of the instrument, and microscope makers will (as some of them do already) recognize the truth that it is for the progress of science and to ameliorate the condition of the human race, that the use of the instrument has been revealed to man.

A remarkable omission, too, in the work before us, seems to be the absence of any mention of micro-photography, or of the apparatus employed in the development of this most interesting branch of microscopical science. If this omission is to be explained on the ground that the author's firm does not interest itself in the art, then, of course, it must be reckoned as one of the disadvantages of the work being an adjunct to their own labours only, but surely it would in no way injure them, and would materially increase the value of the book in a literary sense, if some details were added in a later edition concerning the application of the camera, and even of the spectroscope, to the instrument so ably described by the author.

Of the publisher's share in the work it is hardly necessary to speak. Mr. Van Voorst appears to be determined that whilst his name is linked with science, it shall add lustre to its efforts, and it is always with renewed pleasure that we take in hand a fresh volume from his workshop, our sole regret being that they are so few and far between as compared with former times.

We wish Mr. Beck a large circulation for his interesting work, and

although it is published with a view to an increased demand for the instruments he seeks to recommend, this in nowise lessens its value in our estimation as a literary effort, and if successful, it will be doubly productive of benefit to microscopical science.

THE BATS OF NORTH AMERICA.*

Bats, "the onely bird that suckleth its little ones," in the quaint language of Holland, the translator of Pliny, exhibit the most complete modification of the mammalian form for flying purposes. For although there are flying lemurs (Galeopithecus), flying squirrels (Pteromys), and flying opossums (Petaurista), in all these cases the furred skin extends laterally from the sides of the body, and is attached to the anterior and posterior extremities of the metacarpal and metatarsal regions respectively, but is not associated with any especial osseous framework, such as is afforded by the elongated fingers of the bats. The bones of the Cheiroptera, too, do not communicate with the air, as do the bones of birds; but they are of extreme lightness and tenuity, the skeleton of the common brown bat of North America (V. subulatus) weighing only eleven grains. The skull, however, which in birds is light and toothless, is in bats large and rounded, containing from 30 to 38 teeth, usually four incisors in the upper and six in the lower jaw, canines, and molars which never exceed (true and false) six above and six below on either side. These differences in the number of the teeth form important characters in classification. To balance the weight of the head, there is great development of the ribs, sternum, and scapula, for the attachment of strong muscles of flight, as well as a long and strong clavicle. The senses of hearing and of touch are, in bats, remarkably developed, and each is accompanied by growths, which are very characteristic of the Cheiroptera, *viz.* the enormous ears, and the singular and grotesque leaf-like appendages situated upon the nose. The ears, both externally and internally, are highly perfected. The cochleæ are disproportionately large, as compared with the size of the semi-circular canals, the ampullæ very large; and to this osseous framework for the reception of sound, is added a complicated auricle, such as all insectivorous bats are provided with, and which is frequently larger than the head, and of a great variety of shapes, which are of great importance in classification.

The dermal growths of the nose are situated about the nostrils, and are either simple, upright, triangular folds of skin, or they may be exceedingly complicated in structure. No North American bat, with the exception of Macroticus Californicus, has such a development. These appendages are reduplications of skin, and are not related to the lining membrane of the nose, and it is doubtful whether they hold a definite relation to the olfactory sense. They are pro-

* 'Monograph of the Bats of North America.' By H. Allen, M.D., Assistant-Surgeon, U.S.A. (Smithsonian Miscellaneous Collections.)

bably the agents for augmenting the sense of touch alone, and in this way act conjointly with the wing membranes, in which the sense of touch chiefly resides, and in which the papillæ of touch are extensively distributed. This function is, in many places, aided by the delicate hairs which are sparsely distributed upon the under-surface of the membranes.

The subjects of this monograph are animals which have scarcely met with their due share of attention, not that they are undeserving of notice, for few orders are more interesting; but their crepuscular and nocturnal habits render them difficult of observation. This fact is well illustrated by the history of British Bats. Gilbert White remarked in his day, "At present I know only *two* species of bats, the common V. murinus (the Vespertilio pipistrellus of recent authors), and V. (Plecotus) auribus." He himself added a third species to the list, and his editor, in 1835, enumerates seven species. In Bell's 'History of British Quadrupeds,' seventeen species are described, and others have since been recognized as inhabiting this country. It is worthy of remark, however, that of the seventeen species described by Bell, seven or eight have as yet only been represented by a single specimen, or taken in a single locality, a sufficient proof that we are in comparative ignorance of these animals; and that further research will infallibly be rewarded by the discovery of additional species.

The habits also of the known species are very imperfectly understood. The inaccessibility and dismal situation of their retreats, render it matter of great difficulty to secure them while hibernating; and it is only by sheer accident that they have been found under these circumstances. Opportunities, however, are occasionally offered to observe their flight and their habits of repose, by their accidental entrance into the open apartments of dwellings in warm weather, when they are readily caught, though they do not bear captivity well. They will then eat raw meat with avidity, but, curiously enough, refuse to partake of insects. They also lap up water eagerly; in fact, the first act of a bat, after emerging in the evening from his retreat, is to fly to the water.

The numerous parasites which infest bats constitute, perhaps, the most revolting feature in the history of these creatures. The enormous population of *acari* found upon their bodies is due to the great generation of animal heat in their close haunts, a condition conducive to the rapid increase of all kinds of vermin. In America the common bed-bug (Cimex lectularius) is frequently found upon their fur, and this is believed to be the cause of the introduction of this pest, in many instances, into homesteads from which general cleanliness would otherwise banish them. The immense number of some species may be judged from the fact that in a dismantled and uninhabited house in Maryland, there were found, when it came to be once more tenanted, myriads of a small black species of bat, which issued forth in clouds at the cry of the whip-poor-will to feed upon gnats and mosquitoes. Measures having been taken to rid the place of the pest, it was found by actual counting that nine thousand, six hundred

and forty bats were destroyed in the main building. Their bodies were used as manure, but it required a term of five years to remove the very disagreeable odour that pervaded the building which they had inhabited in such numbers, and this was only effected by a copious use of disinfectants, and a thorough and prolonged ventilation of their holes.

Dr. Allen's memoir is an unpretending volume, published by the Smithsonian Institution, and is designed to exhibit the present state of knowledge of the Bats found in America, north of Mexico. It is based principally on the specimens in the museum of the Smithsonian Institution, although the collections of the Philadelphia Academy of Natural Sciences, and of the Museum of Comparative Zoology at Cambridge, Mass., have also been consulted. The work is illustrated with woodcuts, representing the head, and the skull, and teeth of each species, with enlarged figures of the ear, and generally also the form of the interfemoral membrane; and which contain therefore everything necessary for identification. The number of species described is not great, and does not exceed those known as inhabiting Britain, though of course the species are distinct. The twenty species are arranged in eight genera, of which only one, *Macrotus* (Californicus), possesses an upright appendage upon the nose; the genera Nyctinomus, Nycticejus, and Antrozous, contain each one species; Synotus, two; Lasiurus, three; Scotophilus, five; and Vespertilio, six species. There is but little which here calls for remark in regard to any particular species, inasmuch as they are scarcely so varied in their forms as those found in Britain; and information as to their habits is almost entirely wanting. The genus Synotus is chiefly noticeable for the enormous development of the ears, and the species *Nyctinomus nasutus* for its extraordinary geographical range, the author being confirmed by Mr. Tomes, as to the identity of the species in individuals taken in South America, Central America, South Carolina, and Hayti. The common American species appears to be the red bat (Lasiurus noveboracensis), which is universally distributed throughout the temperate regions in North America, and is moderately abundant. It has long and silky fur of a russet-red colour; fawn, fawn-red, and yellowish-cinereous varieties being met with—differences of hue which are chiefly owing to the coloration of the tips of the hair.

From the references which are given to the specimens contained in the Museum of the Smithsonian Institution, it would appear that all the twenty species described are well represented in that collection, and none (except *Vespertilio affinis*) are represented by only a single specimen. This is a new species, only once taken in Arkansas, and named by Dr. Allen. We should imagine it to be highly probable that the list of North American bats will, in course of time, be considerably augmented by new discoveries, and it seems not improbable that some of the various species described by Rafinesque, Leconte, De Beauvais, Temminck, Say, Audubon, &c., and referred to in the Appendix, may hereafter be rediscovered, and found to be distinct from any contained in the collections.

THE TREES AND SHRUBS OF THE ANCIENTS.

Dr. Daubeny, the distinguished Professor of Botany at Oxford, has just published an essay, on 'The Trees and Shrubs of the Ancients,' as a supplement to his valuable work on 'Roman Husbandry.'*

In the preface, he says:—"The late Professor Sibthorp, in founding a chair of Rural Economy to be attached to that of Botany already existing in the University of Oxford, directed that the holder of that office should deliver, each Term, a lecture on some one of the subjects which the Professorship in question might be regarded as embracing. In conformity with this regulation, I have, besides placing before my hearers from time to time the newest views on the theory of agriculture which modern science had developed, given occasionally such sketches of the husbandry of the ancients as could be gathered from the Scriptores Rei Rusticæ, whose writings have come down to us. The latter have since been embodied in a work published by me in 1857, entitled 'Lectures on Roman Husbandry,' in which I presented 'An Account of the System of Agriculture, of the Treatment of Domestic Animals, and of the Horticulture pursued in Ancient Times,' concluding with notices 'Of the Plants mentioned in Columella and Virgil.' To this publication, the present lectures may be regarded as supplementary, containing, as they do, a summary of the best information I have been able to collect as to the trees and shrubs really intended by those described or noticed in the principal Greek and Roman writers.

In writing the work, the author has availed himself of Sibthorp's 'Flora Græca,' Pliny's works, Sprengel's 'Historia Rei Herbariæ,' Fee's 'Flore de Théocrite,' and 'Flore de Virgile,' J. B. Du Molin's 'Flore Poétique Ancienne,' Billerbeck's 'Flora Classica,' Dierbach's 'Flora Apiciana,' Fraas' 'Synopsis Plantarum Floræ Classicæ,' and Lenz, 'Botanik der Alten Griechen und Römer.'

The book contains an identification of a greater number of Greek and Roman plants than is contained in any former English publication, and is a valuable contribution to our knowledge of the Classical Flora. He first treats of the trees producing fruit, acorns and resin. Many of the trees well adapted for the climate of Italy are traced, according to Pliny, to a foreign source. Amongst fruit trees, we are assured that the cherry, the peach, the quince, the damson, the jujube, the pomegranate, the apricot, the olive, and perhaps the vine were of foreign origin. The common fig was derived from Syria, and the sycamore fig from Egypt. Other fruits appear, like domestic animals, to have followed man in his migration. The orange was not introduced into Italy until the ninth century after Christ. The golden apples of the Hesperides, supposed to be oranges, seem rather to have been a variety of apple. The date palm had been introduced into

* 'Essay on the Trees and Shrubs of the Ancients; being the substance of Four Lectures delivered before the University of Oxford, intended to be supplementary to those on "Roman Husbandry" already published.' By C. Daubeny, M.D., F.R.S., Professor of Botany and Rural Economy in the University of Oxford. Oxford and London: John Henry, and James Parker. 8vo. 1865. pp. 152.

Europe in Pliny's time. The following are supposed to be the species of oak known to the ancients:—

Quercus.

Fruits.	Leaves.	Ancient Names.	Modern Names.
Appearing the 1st year	Deciduous	Robur	Robur.
	„	Esculus	Esculus.
	Persistent	Ilex	Ilex and coccifera.
	„	Suber	Suber.
The 2nd year	Deciduous	Hemeris	Toza.
	„	Cerris	Cerris.
	Persistent	Halephlæus	Pseudo-suber?
	„	Ægilops	Ægilops.

And the following are the species of fir named by Pliny and Theophrastus:—

Leaves in pairs	Pinaster	Pinus halepensis, or maritima.
„ „	Tæda	„ mugho.
„ „	Picea	„ laricio.
„ „	Pinus	„ pinea.
Leaves in fives	Strobus? *	„ cembra.
	Excelsa †	
Solitary, Evergreen	Abies	Abies pectinata.
„ „	„ gallica	„ excelsa.
Fascicled, deciduous	Larix	Larix.

In the second lecture, the author considers the trees not included by Pliny under the head of Piciferæ, Cedar, Juniper, Citrus, Cupressus, and Taxus, as well as others, such as the lime, maple, thorn, ash, elm, alder, willow, poplar, birch, plane, &c.

In speaking of the Cedar of Lebanon, the author repeats an apocryphal story in regard to its introduction into the *Jardin des Plantes* from the Holy Land, in 1737, by Bernard de Jussieu. A romantic account is given of the difficulty this naturalist experienced in conveying it to France, owing to the tempestuous weather and contrary winds he experienced, which drove his vessel out of its course, and prolonged the voyage so much, that the water began to fail. All on board were consequently put upon short allowance; the crew, having to work, being allowed one glass of water daily, the passengers only half that quantity. Jussieu, from his attachment to botany, was induced to abridge even this small daily allowance, by sharing it with his plant, and by this heroic act of self-sacrifice, succeeded in keeping it alive till they reached Marseilles. Here, however, all his pains seemed likely to be thrown away, for as he had been driven, by want of a flower-pot, to plant it in his hat, he excited, on landing, the suspicion of the custom-house officers, who at first insisted on emptying the strange pot, to see whether any contraband goods were therein

* Only mentioned once by Pliny, lib. xii. 40, as used in fumigations. It seems rather rash to identify it, as Fraas has done, with the modern *Cembra.*

† Identified by Dr. Hooker with the *Pinus Peucè* of Griesbach, which that botanist had noted on Mount Peristeri, in Macedonia, and had considered as intermediate between *P. cembra* and *P. strobus.*

The P. excelsa, so common in the Himalayas, has not been observed nearer to Greece than Afghanistan, a distance of more than 2,200 miles.

concealed. With much difficulty he prevailed upon them to spare his bantling, and succeeded in carrying it in triumph to Paris, where it flourished in the *Jardin des Plantes*, and grew until it reached 100 years of age, and 80 feet in height. In 1837 it was cut down to make room for a railway, and now the hissing steam engine passes over the place where it stood.

We are astonished at this statement, and in commenting on it we give the following remarks of Dr. Asa Gray :—

"Of course, it is almost unnecessary to say that Bernard Jussieu never visited the Holy Land, and was not likely, if he had, to come home bare-headed, using his hat the while for a pot; that the fact, or at least the accepted tradition, is merely this, that he brought the seedling Cedar from *England* to Paris in his hat. The story of the voyage from the Levant to Marseilles appears to be an adaptation of one about the three Coffee-plants, which *Antoine* de Jussieu, in the year 1720, sent from the *Jardin des Plantes* to the vessel commanded by Captain Declieux, who was charged by the French Government with the duty of transporting them to Martinique. The voyage being unusually long, the water is said to have failed, two of the precious plants died, and the remaining one is said to have been kept alive by the devotion of the Captain, who bestowed upon it his own scanty ration of water, and so preserved the ancestor of all the Coffee-plantations of the Antilles. For this devotion, we presume, his name is commemorated in the genus *Declieuxia*, of the Coffee family. What are the other ingredients of this *pot-pourri* we are unable to conjecture. But the naturalists of the *Jardin des Plantes* may be somewhat astonished to learn that a railway traverses their peaceful grounds, and that a hissing steam engine runs over the steep little hill upon which flourished, and as we fondly imagine still flourishes, Bernard de Jussieu's Cedar of Lebanon."

The third and fourth lectures are devoted to various shrubby plants of Greece and Italy. In speaking of the Vine, Daubeny says :—"Some of the varieties of Vine described by ancient writers seem to exist at the present day—a fact worthy of notice with reference to the much-disputed question as to the dying-out of species. Thus Pliny notices a Greek Vine in a manner which would lead us to believe it meant for the Corinth or Currant of the Greek Islands. Columella also mentions that this variety of Vine was cultivated in several parts of Italy as well as of Greece; and Mr. Hogg states that it grows abundantly in the Island of Lipari, where it is called *Passolina*.

The engraving in the Vienna edition of Dioscorides will probably be considered as bearing more resemblance to the currant vine than to the ordinary one; and Dioscorides makes mention of two varieties, one probably the common *Vitis vinifera* in its wild state, the other the *Vitis labrusca*, with a woolly leaf, the parent, as it would seem, of the currant or Corinthian grape. I may add that, according to Count Odart, one variety of vine, now called *Pinceau*, was known so long ago as 1394. Another, planted in Andalusia by the Moors, still retains its characters; and that the *Cornichon* of Paris was described six centuries ago by an Arabian writer under the name of Lady's

Finger. A catalogue is given of the trees and shrubs indigenous in Greece and Italy, with the ancient Greek and Latin synonyms.

Dr. Daubeny remarks on the small progress made in natural knowledge between the period of Alexander and Trajan, a distance of time amounting to not less than 400 to 500 years. In accuracy of information, Theophrastus and Aristotle both greatly exceed Pliny, whose work, although invaluable as a Cyclopædia, bears evident marks of being a compilation, and not the result of original research.

"The Romans, indeed, seemed to have acted towards the Greeks as our Mediæval writers did towards the Ancients, and instead of observing for themselves, were contented with copying from preceding authors, whose statements had with them the force and authority of ocular demonstration. Thus there is often a remarkable similarity between the descriptions of plants given by Pliny and Dioscorides, showing either that one copied from the other, or that both derived their information from some common source. Yet neither writer ever alludes to the other. The works of Columella, too, are, in most respects, an amplification in more elegant Latinity of the earlier writings of Cato and Varro, and very possibly the two latter would have been found to be taken from the great Carthaginian work 'On Agriculture,' by Mago, if the latter had come down to us. How mortifying it is to think, that whilst these repetitions of facts, and even of old fables, recorded by many of the authors referred to, might have been so well spared, we should have to deplore such gaps in the history and literature of antiquity as have arisen from the loss of many of the books of Livy, and from the almost entire destruction of the Comedies of Menander and Epicharmus."

Dr. Daubeny's work is one of much interest, and is valuable not merely to the Botanist, but to the Philologist and Antiquarian. We recommend it as containing information which cannot easily be procured elsewhere.

SCIENTIFIC ASCENTS OF MONT BLANC.

Charles Martins gives a notice of two scientific ascents of Mont Blanc.* He describes, in the first place, the ascent of Horace Benedict de Saussure in 1787, and gives full details of the results of his labours. This first grand scientific ascent has served as the model of all others. During a space of fifty-seven years, from 1787 to 1843, there were twenty-seven ascents of Mont Blanc; but none of these were of a truly scientific character. A noble curiosity—a desire to visit the world of snow and ice, and to enjoy from the summit of Mont Blanc one of the grandest views which man can contemplate; such were the motives by which the greater part of travellers were actuated. Nevertheless several travellers published some interesting

* 'Deux Ascensions Scientifiques au Mont-Blanc, leurs résultats immédiats pour la Météorologie, la Physique du Globe et les Sciences Naturelles.' Par Charles Martins, Professeur d'Histoire Naturelle à la Faculté de Médecine de Montpellier. 8vo. Paris, 1865. pp. 38.

scientific facts as the results of their ascents. We may notice specially that of Francis Clissold on 18th August, 1822. That of Marckham Sherwill on 26th August, 1825; of Auldjo, on 9th August, 1827; and of Dr. Martin-Barry. Since 1844 the ascents have been numerous, and at the end of 1863 the actual number has risen to 171, of which three were made in June, thirty-six in July, eighty-four in August, forty-seven in September, and one in October. The extreme dates are 1st June, 1858, the ascent of J. Walford; and the 9th October, 1834, the ascent of M. de Tilly, who came back with his feet frozen, and suffered for a long time from this rash attempt at an advanced period of the year.

The author then gives an account of a scientific ascent made by himself in 1844, with his friends Auguste Bravais, a naval lieutenant, and Auguste Lepileur, a doctor of medicine. With the former he had visited Spitzbergen in 1838 and 1839, and had sojourned on the Faulhorn, in 1841, for eighteen days, at the height of 2,680 metres above the level of the sea. Minute details are given of the preparations made and of the various phenomena observed. The following are the plants noticed on the Grands Mulets:—Draba fladnizensis, Wulf.; D. frigida, Gaud; Cardamine bellidifolia, L.; C. resedifolia, Saut.; Silene acaulis, L.; Potentilla frigida, Vill.; Phyteuma hemisphericum, L.; Pyrethrum alpinum, Willd; Erigeron uniflorus, L.; Saxifraga bryoides, L.; S. groenlandica, L.; S. muscoides, Auct.; S. oppositifolia, L.; Androsace helvetica, Gaud; A. pubescens, DC.; Gentiana verna, L.; Luzula spicata, DC.; Festuca Halleri, Vill.; Poa laxa, Hæncke; P. cæsia, Sm.; P. alpina var. vivipara, L.; Trisetum subspicatum, Pal. Beauv; Agrestis rupestris, All.; Carex nigra, All.

M. Martins gives interesting details of the adventures which he and his friends encountered, and of their scientific researches into the oscillations of the barometer and of the thermometer, the relative humidity of the air at different hours of the day, the temperature of the soil at different depths, the nocturnal radiation of the surface of the snow, the plants and animals observed, the measuring of the proper heat of the sun's rays, the phenomena of glaciers and the physiological effects manifested in the human body. The work is one of much interest, and will fully repay an attentive perusal.

MISCELLANEOUS BOTANICAL WORKS.

Flora Capensis.

The third volume of the 'Flora Capensis,' by Harvey and Sonder has been recently published.* It embraces the Orders from Rubiaceæ to Campanulaceæ, or those Orders of Calycifloræ, which have a

* 'Flora Capensis; being a Systematic Description of the Plants of Cape Colony, Caffraria, and Port Natal.' By W. H. Harvey, Professor of Botany, Trin. Col., Dublin, and Otto W. Sonder, Ph.D., of Hamburg. 3 vols. 8vo. Dublin: Hodges, Smith, & Co.

gamopetalous corolla and an inferior ovary. The work is one of the Colonial Floras, which we owe in great measure to the representations of Sir William J. Hooker. It is executed by Botanists of great reputation, who have personally studied the South African Flora during their residence at the Cape of Good Hope. The fourth volume is now in preparation, and will include the proper Corollifloral Orders, with superior ovaries. The fifth volume will take in all the Monochlamydeæ, and the sixth the Monocotyledons and Ferns, completing the work. The following are some of the remarks in the preface :—

"In undertaking the Flora Capensis, the authors propose to furnish to the colonists in the British South African provinces a clear and concise descriptive catalogue of the vegetable productions of their adopted country. As the colonies have no very definite limits to the northward, neither have the authors been anxious to fix a boundary line to this Flora. Generally speaking, the Cape Flora is limited on the north by the Gariep or Orange River, and on the east by the Tugela—boundaries more convenient than natural, for the Orange River, at its western extremity, rather flows through than bounds the peculiar Desert Flora of Namaqualand; and the Tugela merely limits the British Colony of Natal, while the characteristic vegetation of Kafferland, of which Natal is a section, extends northwards at least to Delagoa Bay, gradually assuming the features of Tropical African vegetation. Whilst, therefore, the Flora is tolerably complete for the old-established colonial district, both of the Western and Eastern provinces, it presents little more than an outline sketch of the Northern and North-Eastern regions, and of the Natal Colony; and still more imperfectly portrays the vegetation of Great Namaqualand, Betchuanaland, the Orange River Free State, and the Transvaal Republic, all lying beyond the Gariep.

"The authors have diligently availed themselves of every accessible collection of plants from the last-named regions; but so few botanical travellers have yet explored them, save in some scattered spots, that their vegetation is as yet all but unknown. From what we know of the plants of Transvaal, especially of its mountains and high plateaux, that country promises to the Botanist the richest harvest yet ungathered in South Africa, and the long mountain range that divides Kaffraria from the Western regions, while it limits the distribution of the greater portion of the subtropical types that mingle in the Cape Flora, probably still retains in its unexplored wilds multitudes of interesting plants. This we infer from the fact that almost every small package of specimens received from the Natal, or the Transvaal district, contains not only new species but new genera; and some of the latter are of so marked and isolated a character, as to lead us to infer the existence in the same region of unknown types that may better connect them with genera or orders already known."

The work is one of vast importance as regards practical and Geographical Botany, and it is the only good work of reference in connection with the Cape Flora. It must be in the library of every Botanist who wishes to study the plants of Southern Africa.

British Flowering Plants and Ferns.*

Professor Henslow was one of the first to publish a list of British plants, with the view of facilitating exchange of plants. He was succeeded in this by the Botanical Society of Edinburgh, which was instituted by students in the year 1836. The Society while it held meetings for the reading of papers, also made large collections of plants for the purposes of exchange. This practice had been long carried on by Edinburgh Botanists, in reference to their private Herbaria, but the Botanical Society took it up on an extended scale. Its members contributed largely—some of them giving between 3,000 and 4,000 specimens to the general stock in one season. Upwards of 100 members contributed, and the distribution of specimens required the united labours of many zealous office-bearers. Rooms in the University of Edinburgh were placed at their disposal, through the kindness of Dr. Graham, the Professor of Botany. By this means a large number of British and foreign species were very widely circulated. The Society still carries on the distribution of specimens, but on a more limited scale. In order to effect exchange it was necessary to have a catalogue of British plants, on which members could mark their desiderata. Accordingly in 1836 such a list was published, and was very extensively circulated. It was arranged according to an alphabetical method, and contained of flowering plants and ferns 521 genera, 1,636 species, and 149 varieties. It also gave information relative to the occurrence of plants within sixteen miles of Edinburgh. The Edinburgh Flora reckoned 715 species and 18 varieties.

A second edition was published in 1841, and contained 545 genera, 1,649 species, and 239 varieties. A third edition, in 1851, contained 565 genera, 1,715 species, and 352 varieties. The present is the fourth edition and contains 568 genera, 1,817 species, and 369 varieties. It is more complete than the former, and indeed is the most perfect catalogue at present in Britain. It has been arranged according to the natural method, and an alphabetical index of genera is added with references to the pages in which the species are to be found.

In addition to the usual list of British plants, the present edition of the catalogue gives, in an Appendix, a full list of the varieties of British ferns, drawn up Mr. P. Neill Fraser. This is a useful list for those who are fern fanciers, and who wish to collect the numerous abnormal forms presented by ferns, whether in a native or a cultivated state.

We look upon this as the best list of the British Flora which has been published, and we consider it well fitted for botanists who desire to keep a record of the plants in their Herbaria, and to send notice of

* 'Catalogue of British Plants, including the Flowering Plants, Ferns, and Characeæ; to which is appended a list of the varieties of British Ferns.' Fourth Edition. Small 8vo. pp. 43. Printed for the Botanical Society of Edinburgh. Edinburgh: Adam and Charles Black. London: Longman, Green, Longman, Roberts, and Green.

their desiderata to the Botanical Society, or to plant Exchanging Clubs. The following plants, among others, are introduced:—Hutchinsia alpina, Viola arenaria, Rosa Bakeri, Pyrus rupicola, Amm majus, Galinsoga parviflora, Acanthus mollis, Neotinea intactai, Demazeria sicula, &c.

Hot-house Flora.

The excellent periodical, known as 'Flore des Serres,'* published at Ghent by Louis Van Houtte, continues to maintain its reputation. It embraces a consideration of all that concerns gardening with reference to usefulness or ornament; the culture of plants in stoves and in the open air; the cultivation of pot-herbs, and of fruit and forest-trees; the description of plants recently introduced into gardens; the examination of questions on Natural History, Meteorology, and General Physics, connected with Horticulture; as well as an account of travels. Each number contains several well-executed coloured plates. In the present number there are figures of Aplotaxis gossypina, a composite plant of the Himalaya, covered with a dense coating of hairs. Dischidia Rafflesiana, an Asclepidaceous plant of Malacca and Singapore, remarkable for its pitcher-like appendages; Maximowiczia chinensis, one of the Schizandraceæ from the Amur district; Phœnieophorium sechellarum, and Verschaffeltia splendida, palms from the Seychelles Islands. The scenery in connection with some of the plants is well portrayed in the coloured drawings. The work does great credit to the editor and to the artist.

Muscology.

The mosses peculiar to Eastern North America have been investigated by Dr. William S. Sullivant, and he has published a work on the subject.† It contains excellent delineations of the mosses with full descriptions, and constitutes a valuable contribution to the muscology of North America. Being entirely of a descriptive character, it is impossible in this notice to give anything like an abstract of the publication. To the practical Botanist who is studying the American mosses, the work is invaluable.

* 'Flore des Serres et des Jardins de l'Europe, Journal Général d'Horticulture.' Tom. xv. livr. ii., 20 Mai, 1865.

† 'Icones Muscorum; or, Figures and Descriptions of most of those Mosses peculiar to Eastern North America which have not been hitherto figured.' By Wm. S. Sullivant, LL.D., &c. With 129 Copper-plates. Cambridge, Massachusetts. 1864.

PAMPHLET.

Beneficence in Disease.*

Discarding the view, long held by all classes of thinkers, that diseases are to be "looked upon in the light of scourges," the author of this pamphlet assumes that they form part of the scheme of Nature for maintaining or restoring the healthy condition of the human race, and he sets out with the inquiry: "What purpose does disease answer in the great scheme of Nature?"

He shows that disease is always preceded by some local or general injury, and that it is the visible effort of Nature to save the subject of the injury from more serious consequences, in fact, as we understand it, from some permanent derangement of a portion of the body or from death. Seeking his illustrations in aural surgery, that branch of the healing art with which he is the best acquainted, Mr. Toynbee tells us that the disease known as Otorrhœa often arises from some violence done to the ear, such as a blow or a prick; or from gout, scrofula, or a general disorder which attacks the ear when that organ is rendered unusually susceptible of attack by some trivial injury, such as a "box on the ear." His meaning will be more fully explained hereafter.

And need there be any doubt as to the correctness of his views, when they are tested by the more extended experience of the human physiologist, or by that of the moralist? In another place † it has been shown that those diseases which have always been considered *par excellence* the scourges sent to punish man—plague, fever, &c.—are the results of injuries inflicted upon society through the neglect of the simplest and best known sanitary laws; and just as gout, or scrofula, is shown by the author to find its expression in Otorrhœa, and when the general injury (gout) is removed, the special disease (Otorrhœa) disappears or is easily cured, so in the larger case where filth, overcrowding, and drunkenness, the general injuries inflicted on society, find their issues in plague and fever, these disappear or are easily combated when houses are ventilated, and the inhabitants become sober, moral, and cleanly, and live in conformity with sanitary laws.

But the author need not even have limited the application of his principle to the *physical* condition of man; for, this being intimately allied to his moral state, the application of the law he enunciates necessarily extends to that also.

If we were to follow the career of a youth who gives himself up to dissipation, we should find that not only is each successive form of disease the means by which Nature seeks to rid the body of some "general injury," some poison that circulates through the system, but

* 'Beneficence in Disease: being an Introductory Address, delivered at the opening of St. Mary's Hospital Medical School, October 1, 1864.' By Joseph Toynbee, F.R.S., &c. Churchill.

† 'On the Predisposing Causes of Pestilence.' Second article in the present Number.

that the infliction itself is reformatory, and cannot in any way be regarded as a scourge. The remorse, and the resolution to reform, sometimes carried out, and at others broken on the recovery of the patient, combine with the physical result of the disease itself to exhibit in a most striking manner the full meaning of the author's title, 'Beneficence in Disease.' If the lesson has been without effect, and the patient returns to the poisoned fountain, inducing successive diseases which at length put an end to his life, it cannot be said that he has been condemned to death by disease, but rather, on the view expressed by Mr. Toynbee, that the general injuries which the sufferer has inflicted upon himself have been so serious as to prevent the visible disease from serving any longer as a corrective, and that he has succeeded in spite of natural safeguards in putting an end to his earthly existence.

Returning to the pamphlet before us, we find the reparative action of disease exhibited in cases which have come under the author's immediate notice; and as they are interesting illustrations of the principle he enunciates, we will extract a few of them for the perusal of our readers:—

"*Case* 2.—A gentleman hunting galloped along a green lane through a wood, and a twig of an overhanging beech-tree penetrated the tube of the left ear and lacerated the drum. Inflammation and suppuration and catarrh of the dermoid layer followed; another form of disease usually called otorrhœa, thus presented itself; after a short time, however, the aperture healed, and the hearing was restored.

"*Case* 2*a*.—A young gentlemen of scrofulous diathesis received from his tutor an unexpected box on the ear. As is not unfrequent, when unexpectedly concussed, the drum was ruptured, pus was soon effused, and what would formerly have been called a troublesome case of otorrhœa set in. For instead of the orifice of the drum healing, as in the former case, the discharge continued for months, and the affection was but slightly influenced by treatment, until the scrofulous tendency had been overcome by general means: then, under the use of local remedies, the healthy state of the drum was gradually restored.

"In these two cases, the reparative character of the disease was, I think, manifest. In the first case the injury to the drum alone had to be repaired; in the second, the injury which the system had suffered likewise demanded repair.

"I will cite two more illustrative cases.

"*Case* 3.—A gentleman, riding at a gate, was carried by the swerve of his horse against a high hedge; pain in the right ear followed and continued to increase for three or four days, although leeches, fomentations, and blisters were resorted to. When called in about the seventh day, I found the dermis much swollen, at its middle part, where a small black point was seen in the centre of the mass. I removed the black speck, which proved to be a thorn, and the patient was speedily well.

"*Case* 3*a*.—A scrofulous lady, who was much out of health, when picking her ear, let a pin fall into the meatus; during attempts at its removal, the point of the pin was pulled by a pair of forceps into the substance of the meatus and there left. Inflammation and suppuration round the end of the pin followed, as in the preceding case, but it extended to the mucous membrane of the tympanum, thence to the membranes of the brain, and caused death.

"In these two cases again, the inflammation and suppuration were palpably for the purpose of removing the foreign bodies. In the first case they were almost successful without the aid of art; in the second, the attempt at the removal of the local injury, which in itself was perfectly adapted to its end, could not succeed because the general injury under which the system laboured, in the form of scrofula, demanded for its relief another and more extensive process, for which the weakened organ to which it was determined afforded insufficient scope. Death accordingly ensued; but death which arose strictly from a struggle towards repair."

The author warmly contests the opinion expressed by Sir John Forbes, that the object of disease is to arrest or destroy life, holding that it would be inconsistent with what we know of the ways of the Creator, that having given to man life with its marvellous attributes, He should send disease to take that life away. We cordially sympathize with Mr. Toynbee in his view of the reparative character of disease, and although he limits his exposition of the law to those forms of it which have presented themselves in the branch of hygiene in which he holds so eminent a rank, we feel convinced that the day is not far distant when its curative and reformatory character will be universally acknowledged, and when that which is now regarded as the disease will be looked upon in a new light, and the disease proper will be sought in what are now considered its predisposing causes.

We cordially commend the little pamphlet to the notice of our readers. It does credit to the head and heart of its author; the statements put forth in it appear to us clear and convincing, and the views enunciated are not only consistent with the dictates of common sense, but they are in conformity with those of the most advanced physiologists, and present another link in the chain of evidence which establishes the unity of design and action pervading the visible operations of Nature.

NOTES AND CORRESPONDENCE.

On the Cerebrum of the Entellus Monkey. (Semnopithecus Entellus). By E. Ray Lankester.

The important discussions which have been going on during the last two or three years, relative to the comparative relations of the brains of man and the higher monkeys, have excited so much interest, that a few remarks on the cerebral conformation of an animal holding a comparatively high position in the quadrumanous series, may not be altogether unacceptable to the readers of this Journal.

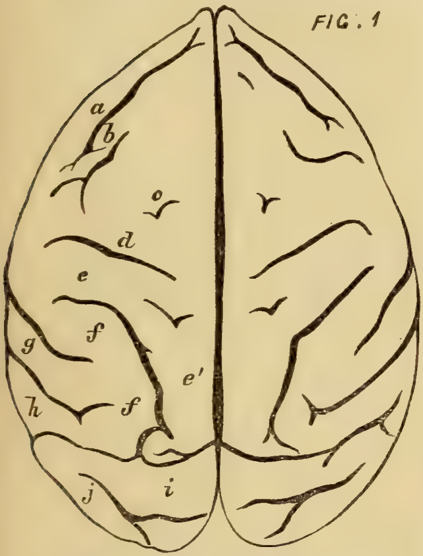
About a year since, I received from the menagerie of the Zoological Society, by the kindness of the secretary, the Entellus monkey, which had recently died. With regard to the anatomy of the other parts of the body, no mention need be made; the brain was carefully exposed by removing the calvarium, and drawings and observations were made. It was then placed in spirits and allowed to harden for several months. The following description of the cerebrum of the Entellus is given from careful examination of this specimen; at the same time, I would distinctly state that in all material points as well as matters of detail, I have only to confirm the observations of that accurate and lamented anatomist, M. Pierre Gratiolet. I have, however, been able to make an examination of the internal modifications of structure in the brain of Semnopithecus, which M. Gratiolet did not consider himself justified in doing with the few specimens preserved in the Museum of the Jardin des Plantes.

From a careful study of the form and arrangement of the cerebral folds and convolutions in the higher quadrumana, M. Gratiolet came to the conclusion that the Orang, the Chimpanzee, and probably also the Gorilla, were almost equally closely related to man, and that they each formed the culminating point of a series having more or less the same peculiarities in brain structure. Beneath the Orang are placed the Gibbons (Hylobates), followed by the Semnopitheci and Cercopitheci, the series thus merging into the smaller monkeys; with the Chimpanzee, in the same way, he associates the Macaci, Rhesus, and Magots, while he conjectures that the Gorilla would form the highest development of a similar series, including the Baboons (Cynocephali, &c.) It will be seen, therefore, that the brain of the Semnopithecus is only three degrees removed from that of man, and holds a position intermediate between that of the Gibbons and the Cercopitheci. The truth of M. Gratiolet's propositions with regard to the three types of arrangement of the cerebral convolutions cannot be doubted by any one who examines his drawings; it would no doubt be interesting to follow out his line of argument, and to see on what grounds the brain of the Semnopithecus has this position assigned to it; but all that I can here do is to examine whether the specimen about to be described furnishes any additional evidence of value by the characters of its internal structure or external conformation, tending to confirm M. Gratiolet's statements.

The general form of the brain of the Entellus, as seen in Fig. 1, is

a very regular, rather broad, oval; when viewed thus in the skull after the removal of the calvarium, *no portion* of the cerebellum is visible, the cerebrum *completely covers it* and *overlaps* it to an easily appreciable

FIG. 1



extent. The convolutions of the upper face are drawn in Fig. 1. It will be observed that the two hemispheres are nearly symmetrical with regard to the disposition of the sulci, though not completely so. I found, however, that in my specimen the differences between the two hemispheres were identical with those given by Gratiolet in his figure. The parts lettered *a*, *b*, *c*, are the three portions of the frontal region, respectively inferior, middle, and superior. The large development of the superior frontal region is a sign of elevation in monkeys—as the greater comparative size of this part of the brain in man is one of the chief points of difference between him and the higher apes. The Orangs, Gibbons, and Semnopitheci, have this portion of the brain developed to a greater extent than the series formed by the Chimpanzee, Macaci, &c., and hence, perhaps, the Orang should be placed nearer to man than the Chimpanzee, while the Semnopithecus would hold a higher place than the corresponding forms in the other series. The parts marked *d*, *e*, *e'*, *f*, form the parietal region of the brain, *d* being "the first ascending convolution," *e* "the second," *e'* "the lobe of the second ascendiug convolution," and *f* "the curved convolution." The fissure separating the curved convolution from the lobe of the second ascending convolution is well marked in the Entellus, and is immediately connected with the deep incision which separates the parietal from the occipital region *i*, *j*. In the sketch, only the superior and middle portions of the occipital region are visible; its inferior portion is situated below, and is partially seen in the lateral view of the internal face (Fig. 2).

Above the letter *g* in Fig. 1, which marks the inferior marginal convolution, is the fissure of Sylvius, separating the tempero-sphenoidal region of the brain from the parietal. In the Semnopitheci the fissure of Sylvius is free and open throughout; in the allied Cercopitheci its summit is hidden under the folded convolution *f*. The middle temporal convolution *h*, and the inferior marginal *g* are all that are visible of the tempero-sphenoidal lobe on the superior surface.

The principal fact which is observable on comparing the brain of this monkey with the drawings and descriptions of the brains of Gibbons and Cercopitheci, is that in the Semnopithecus there is a development of the frontal region intermediate between what is observable in these two: as Gratiolet says "the frontal lobe is advanced towards the posterior parts of the brain; the anterior region is developed at the expense of the posterior;" thus indicating an advance on the brain of the Cercopi-

thecus, but not reaching to that of the Gibbon. The folded convolution *f* is not sharp, as in the Cercopitheci, but is less elevated, and describes a rounded curve; its descending branch is larger and thicker at its root, which becomes developed, and presents a feeble, but distinct swelling. The fissure of Sylvius and its marginal folds, in consequence of this increased anterior development of the cerebrum, present an increased angle, whilst the occipital lobe is much reduced, two deep fissures dividing its superior and middle portions. The superior connecting convolution (*pli de passage*) in Semnopithecus is largely developed and entirely superficial, and in consequence of the fissure being obliterated the operculum is not developed at its superior part. The second connecting convolution is not obvious.

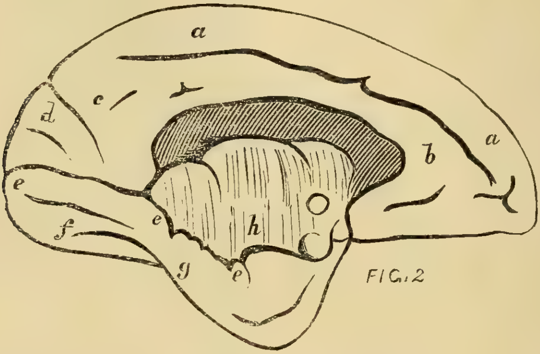
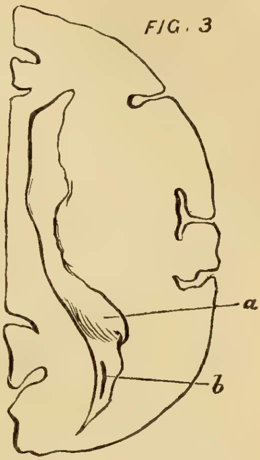


FIG. 2

M. Gratiolet was unable to examine the internal face of the cerebral hemisphere in the Semnopitheci on account of the specimens he had at hand being few in number. I have opened the brain in my possession, and an outline of its internal folds and fissures is given in Fig. 2: *a* is the convolution of the external zone divided by a deep fissure from *b*, the convolution of the internal zone, and *c*, the quadrilateral lobe; *d* is the internal occipital lobule; *e* the fissures of the hippocampi; *f* the inferior temporal fold, and *g*, the middle internal temporal fold; *h* is the "pli godronné." The quadrilateral lobe is of larger size than in the Cercopitheci; the occipital lobule is smaller, and the fissures of the hippocampi are much simpler and straighter. There is also about the posterior surface a greater freedom from plication, and a more definite separation of the occipital lobule and temporal folds than in the Cercopitheci. Now from his extensive researches on the cerebral anatomy of Quadrumana, M. Gratiolet has been led to lay down the following law: That the higher a monkey is in the series leading up to man, the larger will be the development of the quadrilateral lobe, and the greater the simplicity of the fissures of the hippocampi, and *vice versâ*. Hence the examination of the internal surface of the cerebral hemispheres of Semnopithecus confirms their position above Cercopithecus; since it shows that they present characters entirely coinciding with M. Gratiolet's statement deduced from the study of other brains. It may be well here to give the external characters also, which according to M. Gratiolet's most trustworthy deductions, determine the relative position of a brain in the simious

series. The characters of an elevated brain are: 1st, the large size of the frontal lobe, particularly of its superior portion; 2nd, the large size of the lobule of the second ascending convolution, and the simultaneous development of all the external connecting convolutions; also the reduction of the ascending roots of the ascending convolutions; and the diminution of the ascending branch of the curved convolution. The small size of the occipital lobe and of the marginal convolutions are in all monkeys to be regarded as signs of elevation.

With regard to the lateral ventricles, I may observe that by carefully removing the brain tissue they were exposed (as in Fig. 3); both anterior and posterior cornu were well developed, and the hippocampus major *a* was sufficiently obvious, while a small protuberance on the inner wall of the posterior cornu was noted, which may undoubtedly be regarded as the homologue of the much canvassed hippocampus minor. The ventricles were shallower, and their parts less defined than in higher monkeys, but it



was not difficult to ascertain the homologous parts.

E. Ray Lankester.

Downing College, Cambridge, June, 1865.

The Sahara and the North-East Trade Wind. By W. Pengelly, F.R.S., F.G.S., &c.

The exigencies of time and space forbid me, on the present occasion, to take up *all* the questions raised by the Rev. H. J. Ward's note "On the Connection between the supposed Inland Sea of the Sahara and the Glacial Epoch," which appeared in the last (the April) Number of the 'Quarterly Journal of Science.' There is one point, however, to which I may be permitted to call attention. Mr. Ward believes that to the question "What causes the N.E. Trade-wind?" most geographers will reply without hesitation, "Mainly the Sahara" (p. 357).—Again, he says, at p. 358, "Suppose the Sahara then, to be an expanse, not of *sand*, as now, but, as formerly, of *water*; what would be the results? * * * * * The trade-wind would cease, or be so reduced in strength as to exert but slight pressure on the surface of the Atlantic."

Let it be granted that the Sahara is more heated than the land and water surrounding and near it; it will follow that its atmosphere will be expanded, diminished in weight, will ascend, and thereby produce a vacuum, into which, under normal conditions, the air from *all* sides will flow. That on its eastern margin will acquire an apparently westerly motion, and that on the west will move in a relatively easterly direction; — correctly, the easterly motion which the atmosphere possesses in consequence of the earth's rotation will be diminished in the first case and augmented in the se-

cond. But of the currents whose initial movements are in a meridional direction, that on the north will successively reach parallels moving more and more rapidly eastward, and, by lagging behind, will, by the parallelogram of motion, move relatively from between the north and east; whilst, from the reversal of conditions, the current from the south will have an apparent motion from the south-west. Instead, therefore, of being mainly the cause of the north-east trade-wind, the Sahara must have a tendency to produce a westerly wind on its Atlantic margin; and this is borne out by the facts of the case. (See 'Penny Cyclopædia,' art. "Atlantic," vol. iii. p. 27; and Captain Basil Hall's 'Fragments of Voyages,' second series, chap. vii.)

The Sahara, therefore, consistently employs its great power to destroy the uniformity of the trade-wind; let it be submerged, and the westerly winds which now prevail between Cape Bojador and the mouth of the Senegal will disappear with it, and the N.E. trades will receive an accession of territory and probably of intensity.

If it were true that the Sahara mainly causes the N.E. trade-wind, or increases its strength, the heated land of India, during the interval between the spring and autumnal equinoxes, should augment the force and confirm the uniformity of the north-east trade of the Indian Ocean; instead of which it not only strangles it, but actually sets up a rival in the form of the south-west monsoon. In fact, it produces an effect which only differs from that caused by the Sahara on the Atlantic bordering the north-west of Africa, in being periodical while the latter is permanent.

Assuming, therefore, that during the submergence of the Sahara the Atlantic was, as now, an open ocean, the north-east trade wind would prevail over a larger area than at present; its force would probably be greater; the Gulf Stream would consequently be of somewhat greater volume, or velocity, or both; and its effect would be to that extent even more anti-glacial than it is under existing conditions.

W. PENGELLY.

Lamorna, Torquay,
May 1, 1865.

Books received for Review.

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SATURN AND ITS SYSTEM. By Richard A. Proctor, B.A., late Scholar of St. John's College, Cambridge. 260 pp. 8vo. 14 Plates.

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ON RADIATION. By John Tyndall, F.R.S. 62 pp. Post 8vo.

THE "FLINT IMPLEMENTS" FROM DRIFT, not authentic. Beinga Reply to the Geological Evidences of the Antiquity of Man. By Nicholas Whitley.

MAN, CONSIDERED SOCIALLY AND MORALLY. By George Sparkes, late Madras Civil Service. 165 pp. Fcap. 8vo.

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PAMPHLETS.

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Reports by the Medical Officer of Health for the City of Glasgow. April and July, 1863; October, 1863; January, 1864; August, 1864. (Glasgow: Anderson.)

Report on the Health of Liverpool during the year 1864. By W. S. Trench, M.D. (Liverpool: Greenwood.)

Lodging-house Committee's Report, 1864 (Liverpool Health Committee). (Liverpool: McCorquodale.)

Commission des Logements Insalubres (Ville de Paris). Rapport Général sur les Travaux de la Commission pendant les Années 1852, 1853, 1854, 1855 et 1856. (Paris: C. de Mourgues Frères.)

Ditto ditto Années 1857-9.

Ditto ditto „ 1860-1.

Agricultural Education. By J. Chalmers Morton. (Read before the Royal Agricultural Society.)

Auriferous Quartz Mining. By Thomas Belt. Reprinted from the 'Mining Journal' newspaper. ('Mining Journal' Office.)

On the alleged Submarine Forests on the Shores of Liverpool Bay and the River Mersey. By Joseph Boult, F.R.I.B.A. (Liverpool: Brakell.)

The Declaration of Students of the Natural and Physical Sciences. (Simpkin, Marshall, & Co.)

On the Geology of Gloucestershire in reference to Agriculture and Rural Economy. By James Buckman, F.L.S., F.G.S. (Clowes & Sons.)

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On the Wear and Tear of Steam Boilers. By F. A. Paget, Esq., C.E. (London: W. Trounce, Cursitor-street.)

A Lecture on Labour: its Influence and Achievements. By William Fairbairn, C.E., LL.D., F.R.S.

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List of the Diatomaciæ occurring in the Neighbourhood of Hull. By George Norman.

PERIODICALS, AND PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The Geological Magazine. (Longmans.)

Bulletin Mensuel de la Societé Imperiale d'Acclimatation. (Paris: Masson.)

Journal de Medicine Mentale. (Paris: Masson.)

The American Journal of Science and the Arts. Conducted by Professor B. Silliman and James D. Dana.

THE CANADIAN NATURALIST AND GEOLOGIST: with the Proceedings of the Natural History Society of Montreal. (Montreal: Dawson. London Baillière.)

THE ARCHIVES OF MEDICINE. Edited by Lionel S. Beale. (Churchill & Sons.)

THE JOURNAL OF THE SCOTTISH METEOROLOGICAL SOCIETY. (Blackwood & Sons.)

THE TRANSACTIONS OF THE DUDLEY AND MIDLAND GEOLOGICAL AND SCIENTIFIC SOCIETY AND FIELD CLUB. (The Society.)

THE PROCEEDINGS OF THE COTTESWOLD NATURALISTS' FIELD CLUB. (The Society.)

TRANSACTIONS OF THE LIVERPOOL LITERARY AND PHILOSOPHICAL SOCIETY.

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CONTENTS OF No. VIII.

OF THE

QUARTERLY JOURNAL OF SCIENCE,

INTO WHICH THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL

IS NOW MERGED.

OCTOBER, 1865.

ORIGINAL ARTICLES.

CHRONICLES OF SCIENCE.

CHRONICLES OF SCIENCE—*continued.*

REVIEWS.

PROCEEDINGS OF THE BRITISH ASSOCIATION AT BIRMINGHAM.

NOTES AND CORRESPONDENCE.

ERRATA.

Page 430, line 26 from top, *for* Sitonia, *read* Sitona.
,, 431, ,, 25 ,, *for* Silvia, *read* Sylvia.
,, ,, ,, 32 ,, *for* Fringilla montana, *read* Accentor modularis (hedge-sparrow).

THE QUARTERLY

JOURNAL OF SCIENCE.

OCTOBER, 1865.

ORIGINAL ARTICLES.

ON CIRCULATION AND COMMUNICATION IN RAILWAY TRAINS.

By CAPTAIN TYLER, Royal Engineers, Railway Department, Board of Trade.

IT is only within the last few years that science has rendered it practicable, and the development of traffic profitable, to convey passengers between certain places for two hours continuously at an average speed of forty-five miles an hour. We have, however, arrived at that stage of progress. Trains run daily between London and Dover, by the South-Eastern Railway, a distance of 88 miles, in 1 hour and 55 minutes; from Chester to Holyhead, 84 miles, in 2 hours and 7 minutes; from London to Rugby, 82½ miles, in 1 hour and 50 minutes; from London to Swindon, 77½ miles, in an hour and a-half; and from London to Peterborough, 76¼ miles, in 1 hour and 37 minutes. We may also go any evening from London to Manchester, 196¾ miles, in 5 hours; or any day from London to Edinburgh, 399½ miles, in 10 hours and 30 minutes; or from London to Inverness, 604½ miles, in 18 hours and 5 minutes. We undoubtedly perform these and other journeys in a most luxurious manner as compared with the road travelling of former days, or of the present day. First-class passengers sit on soft cushions, second-class passengers sometimes on harder ones, and third-class passengers are almost always provided with seats and sheltered from the weather. But there are inconveniences still to be overcome, and many improvements to be effected. Fixed periods of stoppage at suitable intervals, or a few minutes extra at certain stopping stations would, with the present arrangements, be a great boon to ladies and children, to the weakly and the infirm. The refreshments to be obtained at most of the stations are a disgrace to the country. Better means of sleeping

might easily be afforded on long night journeys. The insertion of a little vulcanized india-rubber between the bodies and the framing of the carriages would render talking less laborious, reading less difficult, and writing quite possible, in day journeys. Many broken legs and severe contusions would be avoided if pads were more commonly added to the edges of the seats in second and third class carriages; and life and limb are often sacrificed when stronger carriages, with a greater proportion of break-power in the trains, would save them. The carriage lamps, from being ill-constructed, out of repair, or badly trimmed, often burn dimly or go out altogether. Improvements in the construction and maintenance of the permanent way and the rolling-stock; locking apparatus at junctions, which render it impossible for the signalman to make such a mistake in working his points and signals as shall lead to a collision; safety tyres, which cannot fly from the wheels or cause an accident when fracture occurs,—have been, or are being, less rapidly adopted than might be expected from the great advantages that they afford. And we are still, in this year of grace 1865, without any means of circulation or of passenger communication in the trains.

A two hours' run without a stoppage is, when all goes smoothly, a charming mode of passing over eighty or ninety miles of ground; and a private compartment for the journey is convenient for a family, pleasant for a bride and bridegroom, and may be suitable to the desire for seclusion which is supposed to be inherent in the English character. The cellular principle, also, has unfortunately grown up with the railway system, and become a fixed institution, with the usual hold on certain prejudices. By means of two doors to each compartment the readiest means of ingress and egress are afforded on either side at the stations, or, when the doors are unlocked, in cases of emergency. But the means of retirement for necessary purposes, or of obtaining refreshments on the journey, are wanting; and when a carriage becomes disabled, or when a lunatic, a drunkard, or a villain forms one of the party, or even when a nervous traveller is left alone with one of the opposite sex, the pleasure of the journey becomes changed into discomfort, terror, danger, or worse. The advantages of separate compartments and isolated carriages are principally on the side of the railway companies, while the comparative privacy is dearly purchased by the passengers; and there is no doubt that the strong feelings which have been lately expressed are only lying dormant until some new case, attended by startling results, calls them forth again, and brings public attention and public discussion once more to bear upon the subject.

As it frequently happens, the case in connection with which the necessity for passenger communication has been most prominently insisted upon, is not only not the strongest that can be urged, but is really not an instance at all in which such communication would have been useful. Mr. Briggs was evidently stunned at once by an unexpected blow. His murder, robbery, and ejection from the carriage, and the escape of the murderer, were all completed within so short a time as to negative the idea of resistance, or opportunity for

the employment of any means of communication that might have been at his disposal. Mr. Briggs was travelling, too, on a line on which the stations were unusually frequent, and by a train which was due to stop every few minutes. Just as it is impossible to prevent a man from striking or even garotting another in the street, or from shooting from behind a hedge, if he be so minded, and if his intentions be not known, so also no facility for communication which could practically be afforded would provide against a sudden attack by one railway passenger upon an unsuspecting and perhaps sleeping *vis-à-vis;* and it would further be difficult to provide for the stoppage of a train, upon a signal of distress being given, more rapidly than this particular train was actually stopped in its ordinary course after the murder. It is a question whether even the deterrent influence of a ready means of communication, which would be very powerful to prevent outrage in many cases, would have had any effect on so daring and determined a villain as Müller. On the other hand, it was the certainty of isolation for a sufficient, though a very short period, that made Müller's project feasible, and his escape comparatively easy; while, if there had been free circulation through the train, with publicity or supervision in the interior of the carriages, he would not have contemplated the commission of such a deed.

But murder, and other deeds of lust or violence, have a command of newspaper space, and therefore, we must suppose, a morbid interest for the public, which is out of proportion to their real significance; and it is not surprising that the murder of Mr. Briggs should have been seized upon to illustrate a real want, which was much and deeply felt, in preference to other and more apposite instances. Passenger communication is more required in cases of accidents to trains, and circulation to prevent offences against individuals. But the circumstances of railway accidents are not, excepting where death ensues, brought to light before any public tribunal; and the official reports in which they are detailed are only presented to Parliament after they have lost their interest for the general public. All serious offences, on the other hand, become immediately the subject of judicial investigation. The evidence in connection with them is placed fully before the public, and they are more readily described and understood.

The most alarming cases of accidents to trains that have happened from time to time, are those in which disabled carriages, or carriages on fire, have been dragged along at high speed for considerable distances, while passengers or their luggage were left behind on the line, without the servants of the company being aware that anything was wrong. And of the numerous offences that have been reported within the last year or two, one of the most striking, perhaps, if not the most important as regards our present subject, was that in which a female passenger was driven by the fear of insult or assault to jump out of the carriage in which she was riding, and to hold on to the outside of a train in motion, at the imminent risk of her life. Space will not admit of the enumeration of many cases, but we may give an outline of two accidents, on which reports were presented to Parlia-

ment in June last,* and which are quite sufficient to show the risk incurred.

On the 21st March last, Sir Charles Fox was travelling with a brother engineer on the Great Western Railway, by the South Wales train which joins the 12.50 A.M. express from Bristol to London at Swindon, when he was awoke at ½ past 3 o'clock in the morning, near Goring, by the fracture of the tyre of a wheel over which he was sitting. The passengers in the other compartments of the carriage shouted with him in chorus, but in vain. One of the guards who rode in the carriage next behind the tender, knew nothing of what had happened until he afterwards heard the break-whistle from the engine; but a second guard, in the fifth carriage, and a third guard in the seventh and last carriage, both felt a shock in running over something which fell upon the rails; and they endeavoured in vain to attract the attention of the engine-driver, by their hand-lamps, and by suddenly applying and releasing their breaks, without themselves hearing the shouting of the passengers. The engine-driver thought the train went a little heavily through the Pangbourne cutting, but he attributed it to the wind, which was strong, and he advanced his reversing lever "another notch." Looking round afterwards to see why his train was so heavy, he observed nothing wrong with it, and was only induced to pull up by the red light of one of the guards. But the train ran upwards of six miles and a quarter before it was brought to a stand, and even then it was a mere chance that the engine-driver's attention was obtained. The passengers were quite powerless, and the guards themselves were making signals without result for a considerable period, during which much risk was incurred.

On the 24th of the same month, Mr. William Baker, the Engineer-in-Chief of the London and North-Western Railway, was travelling from Leamington to London, by the 7.25 P.M. train from Birmingham, on the same railway. The train was composed, on leaving Reading, of an engine and tender, a break-van, a composite carriage, a first-class carriage, and a third-class (break) carriage. Mr. Baker sat with Mrs. Baker, and Mr. Berkeley, a Fellow of Trinity College, Oxford, in a first-class compartment, second of five, in the composite carriage behind the leading van, while Mr. Ransford, of Chancery Lane, was travelling with three other passengers in the last compartment. Soon after they left Reading, and a little before 10 P.M., one of the axles gave way, and the carriage began to jump violently. The passengers, much alarmed, waved hats, rugs, coats, and handkerchiefs, swung the door backwards and forwards, shouted, and did all they could to attract attention; and Mr. Ransford even shook his handkerchief, as he expressed it, frantically in a signalman's face; but neither the engine-driver, nor the guards, of whom there were two, nor the signalmen, of whom there were a considerable number, perceived anything wrong with the train, until the carriage left the rails on a curve at the entrance to the Paddington Station, and ran with some violence against the edge of the arrival platform. In making signals to attract atten-

* Accidents on Railways, January to April, part ii., 1865.

tion, Mr. Baker and Mr. Ransford struck their hands against an obstruction at the side of the line, which turned out afterwards to be a signal-post, and received severe contusions, the former breaking a bone in his arm, and the latter his thumb. The train was a short one, with a guard at each end of it, but it travelled for about thirty-four miles at fifty or sixty miles an hour after the fracture of the axle, without the servants of the company having an idea that anything was wrong. It appears that the passengers were shouting or making signals from the near side, while the guards looked out from and the switchmen were most of them standing on the off-side. The feelings of the passengers may be best described in the words of Mr. Baker:— "We thus had upwards of half-an-hour of awful suspense, during which time we expected every moment to be dashed to pieces; and I may add, that I most seriously regretted the absence of any means of communication with the guard, so that he might stop the train and release us from our perilous position."

A passenger so situated is nothing more nor less than a modern Mazeppa,—quite as helpless, though his limbs be free,—riding farther and faster, though on a more level route,—and just as liable to be "dashed to pieces," though under a carriage roof,—as his ancient prototype; the only difference between them being that the wild horse was only supposed to carry one, while the steam-horse will accommodate any number of victims.

Our neighbours on the Continent are not without similar troubles, as will be seen by the following account, which is one of several, by the Baron de Janzé,* of an accident which occurred on the route from this country to Paris, in the *same month* of the present year, as the two cases related above:—"Le 1er mars dernier, sur la ligne du Nord, et non loin de la station de Boves, un bandage de roue de l'avant-dernière voiture d'un train se brise: les deux roues de derrière quittent les rails, et 500 mètres plus loin, arrachées au wagon auquel elles appartenaient, elles sont jetées sous la dernière voiture, qui déraille, ainsi que le fourgon placé derrière elle. Plusieurs voyageurs sont blessés ou contusionnés, et l'un d'eux, qui avait le bras cassé, est retirée, à l'aide de cordes, par la portière de la voiture renversée sur le coté.

"Le mécanicien continue sa route sans se douter qu'il a perdu un wagon et un fourgon, sans s'apercevoir que la voiture qui a perdu ses deux roues de derrière est traînée sur ses ressorts avec d'horribles secousses, et court à chaque instant risque d'être renversée. Ce n'est que *trois kilomètres plus loin* qu'il s'arrête et constate que, *par bonheur*, cette dernière voiture ne contient pas de voyageurs."

The French have had their murders also, of Heppi and Poinsot, and the young Englishman whose corpse was found near the Villefranche station, on the Mediterranean line, at 5 A.M. on the 30th April, 1864, to set against that of Mr. Briggs; and M. Poinsot's murderer appears to have obtained access to the compartment in

* Accidents de Chemins de Fer, par J. Bisson, publiés et annotés par le Baron de Janzé, Député, Paris, 1865.

which his victim was riding, as well as to have escaped from it, along the footboards. The following, also related by the Baron de Janzé, is, on the other hand, a singular instance of the advantage of being able to use the footboards in the absence of a better means of circulation :—" Il y a quelques jours (16 août, 1863), au moment où le train-poste, arrivé à Evreux à 11 heures du soir, allait repartir, un individu d'assez mauvaise tournure était monté dans un compartiment de première classe où se trouvait une jeune dame avec un autre voyageur. Le train venait à peine de se remettre en marche, lorsque l'intrus, s'approchant de la dame, voulut se porter sur elle à des actes de violence, malgré l'intervention du tiers, témoin de cette scène et trop faible pour l'empêcher d'accomplir son odieux dessein.

" Fort heureusement, les cris poussés par la victime de cette odieuse tentative, et par son défenseur, furent entendus des voyageurs qui se trouvaient dans le wagon voisin. Le sieur Roussel ouvrit la portière, et vint, en longeant les marchepieds, jusqu'au compartiment où la dame, presque à bout de forces, luttait contre son agresseur. Y pénétrant aussitôt, ce libérateur, qui paraît doué d'une énergie et d'une force peu communes, parvint, non sans peine, à terrasser le quidam, cause de ce scandale. Aidé du monsieur et de la dame, il lui attacha les pieds et les mains avec des mouchoirs, et c'est dans cet état que le coupable a été amené à Conches et remis entre les mains de la gendarmerie."

These instances of the dangers of isolation, must, however, suffice, and we will next proceed to consider how they can best be avoided.

In America they do not exist, simply because there is free circulation through all the carriages of a train. Publicity and the means of escape are thus both afforded as safeguards against offence, and a cord running under the roof throughout each train, provides a ready means of giving warning to the engine-driver in case of accident.

In Switzerland and parts of Germany, the same system of circulation through the carriages is in force, and without some of the disadvantages experienced in America, inasmuch as the carriages are separated into compartments of different classes, and the doors between them will open freely, for instance, from the 1st to the 2nd, but not without a key from the 2nd to the 1st class. The *conducteur* is thus in frequent communication with the passengers, he sees their tickets while the train is in progress, and he has them all, as it were, under his eye.

In Belgium generally, and in France partially, as any one may see who travels to Paris by the Chemin-de-fer du Nord, the want of internal, has led to the adoption of external circulation, though not without risk and loss of life. It was calculated in 1860, that one *contrôleur* lost his life every year in Belgium by accident in perambulating the footsteps, besides those who were injured; and as there are ten times as many miles now open in this country as were at that time open in Belgium, we should probably, if we attempted to carry out the same system, lose ten guards a year killed, and others injured.

But there are other reasons why it would be impossible, without extensive alterations, to carry out such a system generally on British railways. The ordinary width of the carriages is 7′ 4″, projecting 1′ 2″, and they are constructed on many lines up to widths of 8 or even 9 feet, projecting 1′ 6″ or 2′ on each side of the rail. The distance between the two lines of rails is 4′ 8½″ or 5 feet on some of the older lines, and 6 feet on modern lines; and the maximum distance between the rails and the side-works varies on different lines. To take an instance, the minimum distance between the outer rails and the side-walls on the London and North-Western Railway is in the following tunnels:—

	Up side.		Down side.	
	Ft.	In.	Ft.	In.
Beechwood Tunnel (near Coventry) . . .	2	3	2	3½
Walford Tunnel	2	3	3	4½
Primrose Hill Tunnel	2	8	2	5

But allowing 2′ 4″ in the clear as the minimum space in which a conductor should be allowed to pass between the outside of a carriage and a standing work at the side of the line, there would then be required, for a carriage 7′ 4″ wide, 3′ 6″; for one 8′ wide, 3′ 10″; and for one 9 feet wide, 4′ 4″, between the outer rail and such standing work. And the dimensions above given are, as will be seen, quite insufficient to provide such spaces, there being only nine inches between the up sides of the two former tunnels and those of a carriage 8 feet wide, and only 1′ 3″ in the case of a carriage 7′ 4″ wide, to allow of the passage of a guard.

The Regulations of the Railway Clearing House contain a very good guide to the minimum dimensions of the works, in the table showing the *maximum dimensions* of a *carriage* or *wagon load* which will travel safely over the different lines in the country. It will be useful here to extract the particulars for a few of the principal Railways:—

	Width of Load.		Height in Centre.		Height at Side.	
	Ft.	In.	Ft.	In.	Ft.	In.
Caledonian and Branches	10	0	14	0	10	9
Except Portpatrick	9	0	12	11	10	9
Great Northern and Branches	9	3	13	9	10	3
Great Western:—						
Broad Gauge	11	6	15	0	11	8
Narrow or Mixed Gauge	9	2	15	0	11	8
Birkenhead	8	9	12	9	12	0
Coleford, Monmouth, Usk and Pontypool . ⎱ Leominster and Kingston . . . . ⎰	8	6	13	0	11	0
Much Wenlock and Severn Junction . . .	9	0	13	0	11	6
Newport, Abergavenny and Hereford . . .	9	0	13	0	11	0
Oxford, Worcester and Wolverhampton . . ⎱ Severn Valley . . . . ⎰	9	0	13	0	11	6
Shrewsbury and Birmingham . . . . . . ⎱ Shrewsbury and Chester . . . . ⎰	7	8	13	4	11	8
Shrewsbury and Hereford	9	0	13	0	11	6

	Width of Load.		Height in Centre.		Height at Side.	
	Ft.	In.	Ft.	In.	Ft.	In.
Great Western (*continued*):—						
South Wales	10	6	15	0	13	0
Stourbridge, Tenbury, Tenbury and Bewdley, Witney	9	0	13	0	11	6
Worcester and Hereford	8	6	13	0	11	6
London and North-Western:—						
Main Line and Branches	9	0	13	3	10	7
Wapping Tunnel, Liverpool	8	10	12	2	8	0
Waterloo Tunnel, Liverpool	9	0	13	3	10	7
Chester and Holyhead	9	0	13	11	13	9½
Knighton	9	0	14	0	12	0
Lancaster and Carlisle	8	3	13	3	11	4
Shropshire Union (except Coalport Branch)	9	0	13	6	11	5
Ditto Coalport Branch	9	13	13	6	10	10
South Staffordshire	8	9	13	0	12	0
St. George's Harbour	8	3	13	3	11	4
St. Helen's	9	0	12	0	11	0
Warrington and Stockport	9	0	13	6	10	8
North British and Branches (except as under)	8	0	12	0	11	0
Burntisland to Perth, Dundee and all Branches	9	0	13	6	10	4
St. Andrew's	9	0	12	2	10	4
Bridge at bottom of Pittencrief incline	9	0	8	9	7	6
Border Counties, Border Union	8	0	12	0	11	0
Carlisle and Silloth Bay, Port Carlisle	9	0	13	6	13	0
North-Eastern (except as under)	9	0	13	6	11	0
Marsh Lane (Leeds) Station	8	0	13	6	11	0
Newcastle and Carlisle Section	8	6	15	0	10	6
Stockton and Darlington Section	8	4	13	6	11	6
Scottish Central and Branches	8	8	13	8	11	2

This subject has also been investigated in France. The Commissioners who were appointed after the murder of M. Poinsot to report upon the security of passengers in railway trains, state in their report of the 12th April, 1861:—"Le contrôle de route, il faut le reconnaître, sera, quoi qu'on fasse, toujours accompagné d'un certain péril. Le prescrire d'une manière absolu sur toutes les lignes et en tous les points, ce serait pour l'administration assumer la responsabilité de graves accidents et jouer un rôle fâcheux auprès des agents des compagnies. Indépendamment de cette considération, nous avons vu que, dans un grand nombre d'ouvrages, il faudrait élargir l'accotement en rétrécissant l'entrevoie, mais que ce rétrécissement ne pouvait dépasser certaines limites."

The carriages in France vary in width from 8′ 6″ to 8′ 8″, and the intermediate space between the rails and the side-works is 4′ 2½″ in the majority of cases, though sometimes less. The French Commissioners considered that the width of a door, or 2 feet in the clear,

would be sufficient for the passage of a *contrôleur ;* and they come to the following conclusions :—

"1. Le contrôle de route est partout impossible du côté de l'entrevoie.

"2. Le contrôle de route n'est possible sur l'accotement qu'avec une distance de 1m. 30 (4 ft. 3 in.) entre l'axe du rail extérieur et les parois d'ouvrages et objets de toute nature placés sur le flanc de la voie. Cette distance de 1m. 30 peut d'ailleurs n'être considérée qu'à 1m. 20 au-dessus du rail (hauteur de l'arête inférieure d'une portière ouverte) ; mais elle doit en revanche régner encore à 2m. 70 (hauteur de l'arête supérieure de la dite portière) au dessus de ce même rail."

And they recommend that "Les compagnies devraient organiser sur toutes les voitures composant les trains de voyageurs un système de marchepieds et de mains courantes horizontales, qui permette, soit aux agents mêmes du train, soit à des contrôleurs spéciaux, de parcourir toute la longeur du convoi du côté des accotements du chemin. Les mains courantes pourront être interrompues devant les portières ; mais elles deborderont, ainsi que les marchepieds, les deux extrémités de la voiture à 25 centimètres au moins de largeur."

The general commission on French railways, which was appointed on the 5th November, 1861, and reported in 1863, stated their own conclusions as follows :—

"3. Que toutes les fois que la composition des trains ne s'y opposera pas, la communication entre les gardes freins et le mécanicien devra être rendue obligatoire ; qu'il n'y a pas lieu de faire de même, en ce qui touche la communication entre les voyageurs et les agents du train."

This question of circulation in trains has, indeed, formed a constant subject of invention and discussion for many years. The Commissioners of Railways issued a circular in October, 1851, pointing out how desirable it was that "the power of travelling along trains whilst in motion should be given to the guards and servants of the Company ;" and several of the English Companies having expressed their willingness to adopt the Belgian arrangement, the consent of the Post Master General was obtained to the addition of steps to the post-office vehicles, with a view to its being generally carried out. In 1852 a sub-committee was appointed by a minute of General Managers at the Clearing House, to consider a proposal from the Board of Trade to use the footboards of the carriages as a means of communication on the outside of trains. This sub-committee drew up a list of queries, and circulated them amongst all the railway companies in the kingdom. They received replies from thirty-five companies, from which it appeared, that there were twenty-three companies on whose lines either bridges, tunnels, or other permanent structures rendered it dangerous to pass along the side of a train in motion ; there were sixteen companies whose station-platforms would have required alteration if the footboards of the carriages had been lengthened ; and all these companies were in the habit of running cattle-trucks or goods-trucks to a greater or less extent with their passenger-trains. All but two stated that no accident had occurred which might have been

thus prevented, and that they considered the power of passing along the footboards would lead to rash exposure on the part of the public. All but five thought that if passengers were able to move from a lower to a higher class of carriage, they would be likely to take advantage of this means of defrauding the companies. All but one thought the system would afford facilities for robbery and assault upon passengers, and especially on females travelling alone. Four companies had employed the system for general purposes, and two especially for the collection of tickets, but one had discontinued it from apprehension of danger, and another after an accident; and a third did not consider that it had been attended with benefit or the reverse. All but three thought that the disadvantages of its adoption would preponderate.

The sub-committee came finally to the conclusion,—

"That there are several railways, the dimensions of whose permanent structures would prevent the plan from being generally adopted, without which it would be inoperative; that the expense of the alteration (which they estimated at 165,855*l.*) would be out of all proportion to the benefit that would be derived from it, that it would expose the public to great danger and to robbery, and the companies to fraud; and that, therefore, it is not desirable to adopt it."

The above apprehensions as to damage to the public were actually realized by the murder of M. Poinsot already referred to; and the difficulties of external communication have since increased, and continue to increase, in consequence of the carriages being frequently constructed of extra width.

It is, indeed, evident, that alterations so extensive as to be hardly practicable, would be required in the rolling stock and works on many of the railways, including most of the through lines, in order to provide at the present time for external circulation. And if the necessary alterations were made, by widening the works and lessening the width of the carriages, by adding convenient handrails and footsteps to all the vehicles used in passenger-trains; and, perhaps, by covering this outside gallery with a framing of bars or network, as has been frequently proposed, the resulting system would still remain open to the serious objections which have already been partially referred to; and the more secure the means of circulation the greater, in one respect, would be the disadvantages attending it. It would be impossible to confine the use of the footboards, or of an outside gallery, exclusively to the servants of the company. Complaints would be made of strange passengers finding entrance to the carriages after the starting of the trains, similar to, but more frequently than, those which have already appeared of their crawling from under the seats. External circulation has not the advantage of publicity, which in the case of internal circulation exercises so wholesome a check on certain passengers, as well as on the servants of the company. Card-sharpers and others travelling for plunder, would find the former convenient, if they happened to start in a compartment ill-suited to their purposes; and, in fact, they would be enabled to visit different carriages, while the train was in motion, in search of prey; or it would, at all events, require several guards in a long train, always on

the look-out, to prevent them from doing so. Neither male nor female passengers would go to sleep with the same degree of confidence in the "limited mails" or other night trains, if they were liable to receive unwelcome visitors of any class, without supervision, at all parts of the journey.

It would appear, therefore, that as a general rule external circulation is in this country neither practicable nor desirable, and that it would be particularly unsuited to those long journeys on which protection is most required. But it is quite otherwise with internal circulation, which, on the other hand, would afford many advantages. The American system could not, of course, be adopted without modification. The sub-committee of the Clearing House which reported on the 9th March, 1853, stated on this point:—"23. And as regards the American arrangement, it is obvious that it is so opposed to the social habits of the English, and would interfere so much with the privacy and comfort which they now enjoy, that these considerations, apart from others nearly as important, would forbid its adoption in this country." And the sub-committee which reported on the 25th of March last, state,—"11. As to the suggestion that the English companies should adopt carriages built upon the American plan, which allows of internal communication from one part of the train to the other by means of a central passage, the sub-committee is satisfied that the habits of English travellers would not tolerate any such system. Apart from the enormous outlay which would be involved in a reconstruction of the stock of the different companies to secure a doubtful advantage, the delays which would arise in the loading and unloading of trains on the great railways of England, particularly in the metropolis and at other great centres of population, would be productive of very serious evils. Any person who has travelled upon railways where these carriages are in use must have observed the great loss of time which is consequent upon the means of leaving and entering them being limited to the doorway at each end, instead of taking place by the more numerous doorways parallel to the platform, as in the ordinary English carriages."

But the second sub-committee seem to go too far in saying that the "habits of English travellers would not tolerate *any* such system." The fact is that neither English nor any other travellers have much choice in railway travelling. Their habits are to a great extent formed for them. They are compelled to avail themselves of the conveyances provided by the railway companies, and are frequently obliged to tolerate that which they would not willingly put up with. The British passenger is only exceeded in patience and forbearance by the railway shareholder, and we make bold to say that both would be quite disposed to acquiesce in any system that may be proved upon full consideration to be the best for his own and the general good. There is no good reason why a means of passing through the trains should not be combined with the separation of classes, and even compartments, by sliding doorways, as well as with a certain number of side doors for facilitating ingress and egress, so as to avoid extra delay to any serious extent at the stations. The Swiss carriages, for

instance, have all the advantages of internal circulation, without the drawbacks of the American cars; and, indeed, carriages to fulfil this condition may easily be constructed in great variety of dimensions, fittings, and doorways, so as to be suited to every description of traffic on different lines in this country. The only real disadvantage—to which the sub-committee have not referred—would be as regards the old carriages, that the number of passengers that could be conveyed with equal comfort, or in proportion to dead weight in each vehicle, would be somewhat diminished. But little or no loss in these respects need occur in carriages specially constructed.

It would certainly take time, and be an expensive process, to re-arrange the internal fittings of the carriages now in use; and the system would be imperfect as long as any carriage with separate compartments were allowed to run. But, looking to the requirements of future years, in the course of which the traffic of the country will, we hope, increase at least as heretofore,—still longer journeys will more frequently be performed without stopping,—and passengers will be furnished at moderate charges with all that they require in the trains, and will not be obliged to leave them during a journey,—it would appear that the system of internal circulation, now much required, will eventually become indispensable. And this remedy is, therefore, one which should be kept in view, and for which preparation should be made, not only for the good of our own, but still more for the sake of the next generation. It would be no hardship on railway companies, but for their future good, and the best method of attaining this object, if it were to be provided by legislative enactment that no passenger carriages should hereafter be constructed for railway purposes without the means of internal circulation, and that all existing carriages should be so far altered within a certain number of years as to fulfil the same conditions. We should then, within say five or ten years, have a complete means of internal circulation in all passenger trains; and the more the subject is considered, the more it becomes evident that this is a most important, if not the principal, desideratum.

In the meantime, as a means of partial publicity, glass has been inserted experimentally in different shapes—either fixed, or to open and shut—in the partitions of some of the carriages on several lines. The French Commissioners who reported in 1861 were, for want of a better, much in favour of this expedient. They stated:— "La glace dormante placée à la partie supérieure des cloisons offre, sur une moindre échelle, quelques-uns des avantages de la communication entre compartiments. Elle peut, dans certains cas, être d'un utile secours aux voyageurs, inspirer une crainte salutaire aux mals intentionnés, et constituer, en tout cas, un épouvantail matériel ou moral. Elle ne porte aucune atteinte ni à la commodité, ni à l'indépendance des voyageurs, qui seront toujours à même d'en masquer l'ouverture, s'ils le jugent à propos. Elle peut, d'ailleurs, être faite avec une très faible dépense. Elle ne laisse en outre passer, ni les paroles des voyageurs, ni les courants d'air, ni la fumée de tabac.

"En conséquence, nous pensons que, par l'application de l'article 12 de l'ordonnance du 15 novembre, 1846, on peut donner la sécurité

publique, une satisfaction aussi peu dispendieuse, et inviter les compagnies à installer immédiatement, dans toutes les cloisons, une ou deux glaces dormantes, ayant un minimum 0 m. 10 de haut, sur 0 m. 25 de large, placées immédiatement au-dessous des filets à menus bagages et pouvant être recouvertes de chaque côté par une pièce d'étoffe mobile." And in reference to their proposals that the companies "*fussent invitées* à pratiquer dans le délai de six mois, dans les compartiments de première et de deuxième classe, des ouvertures fermées par une glace transparente et placées au-dessus des filets à bagages;" and that a means of communication between the guard and the engine-driver should be obligatory "*toutes* les fois que la composition des trains ne s'y opposerait pas,"—M. de Janzé remarks, "Ces demandes étaient modestes, et le sénat, comme le corps législatif, ont chaque année appelé l'attention du Gouvernement sur la nécessité de donner satisfaction aux légitimes exigences du public.

"Cependant les compartiments sont encore aujourd'hui ce qu'ils étaient il y a cinq ans, ou des cabinets particuliers, ou des cellules matelassés, étouffant les cris de douleur et d'agonie."

But, in truth, the transparency of the partition affords no remedy at all for the worst evil—the isolation of the carriages. These portions of glass only afford a more or less perfect means of seeing into an adjoining compartment; and they are rendered useless, either by a curtain drawn across them, or for a whole carriage composed of three compartments, when the centre compartment happens to be empty. They might possibly afford some deterrent protection against insult or outrage, but they would be of no use in case of accident. They would be least agreeable to passengers in long journeys, where protection is most called for, and would afford no means in general of attracting attention from the servants of the company. Even if glass were similarly inserted in the ends of the carriages, and poles were provided to attract attention by rapping from one to another, a luggage compartment, or an empty carriage, or a truck, might still be the means of cutting off communication.

The next requirement, either with or without a system of circulation, is a ready means of calling the attention of the servants of the company in any case of necessity. One difficulty which presents itself at first sight, and which has been put forward by the French Commission, and felt strongly by the sub-committee of the Clearing House, is in effect that communication without circulation is comparatively useless. The French Commission say, for instance, "Mais une réflexion qui n'a pas été assez faite, et qui domine évidemment toute la question, c'est qu'avant de donner au voyageur le moyen d'appeler à lui les agents du train, il faut d'abord donner à ces agents le moyen de se rendre auprès du voyageur, car on ne peut raisonnablement admettre qu'on arrête le train au premier signal émanant d'un compartiment. Il nous semble donc tout-à-fait prématuré de mettre les voyageurs en relation avec les agents du convoi, tant qu'on n'aura pas résolu la question du contrôle de route." The sub-committee of 1853 state, "When discussing and weighing the inferences naturally deducible from the facts and information which it had collected, the

committee gave its attention, in the first instance, to the important question of giving to passengers the power of communicating with the guard. Without overlooking the possibility of such an arrangement being occasionally of service, the committee have been unable to persuade themselves that it would not lead to greater disasters than it could, on any view of the matter, prevent. Unless the guards and engine-drivers had orders to stop the train whenever a passenger made a signal, the privilege would be useless to the latter. It, however, requires little acquaintance with railway travelling to be convinced that its dangers would be greatly increased if the train were to be stopped wherever and whenever a passenger, under the influence of fear or levity, chose to make a signal." And the sub-committee of 1865 quote this passage entire, and say, with regard to it:—"Upon the more important question as to whether, in the interest of the public safety, the means of communicating with the guards should be placed at the disposal of the passengers, the following extract from the Report of 1853 expresses so accurately the objections to such an arrangement that this sub-committee cannot do better than give it a place in this report."

The advantages that circulation would afford have not here been under-estimated, but, on the contrary, much space has been devoted to showing how essential it is, and to pointing out the mode by which alone it can be practically and satisfactorily obtained. And this question has been purposely kept distinct from the question of communication, because it is obvious that much confusion has hitherto been felt from combining the two problems under the one term of communication. It will be seen, on the slightest reflection, when they are treated separately, that a means of communication is even more required when there is no opportunity for circulation, than when the power of circulation exists. Without either communication or circulation, the passenger is completely isolated, and doubly helpless. Free circulation gives, of itself, an admirable means of communication. Ready communication makes up to some extent for the want of circulation.

Passenger communication must not be employed, of course, with a view to enable any passenger to stop a train at any moment. This might, as the sub-committee observe, lead to greater disasters than it could prevent. Its legitimate object would be rather to place it in the power of passengers simply to attract the attention of the servants of the company when anything was seriously wrong. And it is desirable, in this view, that the passengers should signal, not to one or more guards only, but to the engine-driver also, because, in fact, the engine-driver is principally responsible for the progress of the train while it is travelling, and it is of the utmost importance in all cases of emergency that his attention in particular should be immediately awakened. On an alarm being given, it would be for the servants of the company to act according to the best of their judgment. If a carriage were on fire, or off the rails, they would naturally stop the train at all hazards, and the engine-driver would be expected, with the help of the guards, to bring it to a stand neither more nor less suddenly

than was prudent. If a train became divided, the engine-driver ought to be informed of the circumstance at once, as well as the guards, in order that he might act for the best, according to the locality, the speed at which he was travelling, and the gradients of the line. If on an alarm being given no external sign were observed of anything wrong, then it would be the duty of the engine-driver and guards, in the absence of any means of circulation, to bring the train to a stand at the nearest convenient and safe point, say under the protection of the first fixed signals. Where the power of circulation existed, the nearest guard would at once repair to the carriage whence such an alarm had been given.

In order effectually to carry out this system, it is necessary that a means should be provided of ringing a bell, or otherwise calling attention, *in* every break-van in a train and on the engine; and to render it perfect, it is desirable that each guard should be able to send a signal to, or receive one from, the engine-driver at any moment. It is further necessary, in the interest of the travelling public, as well as in that of the railway companies, that there should be a certain means of detecting the compartment from which a signal has been given. The methods proposed for effecting communication have been very numerous. They cannot here be enumerated in detail, but they may be divided as follows into a few classes:—

1. *Sound* signals, such as bells, gongs, firearms, or detonators affixed to the different carriages, connected or not with outside flags, discs, or arms to attract attention to the part of the train whence the sound proceeds. Gong signals of this sort were lately fitted up and tested experimentally by Mr. Edmund Tattersall on the London and South-Western Railway.

Such signals, requiring no extra coupling between the carriages, would be admirable if they could be made efficient. But, unfortunately, there is no certainty of their being heard, even from front to rear, in a long train; and they are frequently inaudible, under the most favourable conditions, when a train is travelling at high speed, towards the front. The rattle of a train, in passing particularly through cuttings, or tunnels, or bridges, is so great as sometimes to render the steam whistle of the engine inaudible to the guard in his van.

On this point the Clearing House Sub-committee of 1853 observe:—"29. The remarks made in a former part of this report, when treating of air whistles, prove that signals depending on sound, if made at a distance from the engine-driver, are as little to be relied on as those depending on sight. Several members of the committee have at various times conducted experiments having sound for their basis; and the result has invariably been that no noise, however loud, shrill, or continued, whether the sound was produced by compressed air, trumpets, or gunpowder, could be heard, even when the train was short, when there was a head wind, or when the speed of the train was considerable."

Of this class, also, those which depend upon gunpowder, or explosive compositions, would be liable, after lying ready, perhaps, for years, to fail when they were required for use.

2. *Sight* signals for day and night on the different carriages, independently of sound. These signals have also the advantage of requiring no extra coupling between the carriages, but a servant of the company must always be specially on the look-out for them.

The system of employing a travelling porter or look-out man was advocated for many years, and employed with some trains, by the Great Western Company; and the look-out box which was constructed at the back of the tender for his accommodation, must be familiar to all who have been in the habit of travelling on that line. But there have been several accidents, including the two above referred to, in which the travelling porter, much required, was not forthcoming. And there are many disadvantages attending such a system. It is difficult to keep a staff of men on different trains always carefully on the look-out for what is very seldom seen, and expensive to employ them for this sole purpose. They would be unable to see along the trains, or to distinguish any signals made to them, during fogs or in the steam and smoke of tunnels. The engine-drivers and firemen have quite enough to do in attending to the engine and looking out ahead, and it would be in the highest degree dangerous to make them responsible for watching at the same time the carriages behind them. The guard or guards have letters, parcels, and luggage to sort and look after, and cannot be expected to keep a constant look-out on the journey.

It has frequently been proposed to place mirrors in various positions on the engine or in the breakvans, in which the whole train shall be reflected, for the benefit of either the engine-driver or the guards, or both; and the experiment was tried in France, on the Montpellier à Cette railway. There has been a further scheme for providing systems of mirrors, by which the interior of every compartment of every carriage in a train should be rendered always visible from the vans of the guards. But these mirrors would require to be frequently cleaned on the journey. Either at the side of the engine or at that of the van they would extend, if of any use, to an inconvenient distance. None of the servants of the company could be expected to be constantly looking into them; and a system of supervision which rendered the interiors of the different compartments constantly visible to persons who could not be seen from them would, even if it could be rendered suitable for adoption in practice, be disagreeable to passengers of both sexes.

The French Commission before referred to remark with regard to the above two classes of signals:—"Les n^os^ 2, 3, 14, 24, consistent des appareils visuels ou sonores placés sur les voitures des voyageurs. Nous démontrons que leurs signaux visuels ne seraient point vus, que leurs signaux sonores ne seraient point entendus."

3. *Apparatus* worked by the *revolving axles* of any of the vehicles of a train. These, whether air-pumps, or magnetic, or other arrangements, require to be adjusted to extreme variations of speed, and are useless when the wheels are skidded by breaks, in slackening speed, or in descending steep inclines. There are difficulties also in arranging most of the apparatus so as effectually to communicate both

between the passengers and the servants of the company, and between the latter only. It is further desirable that the machinery of communication should be independent of the machinery of the train.

4. *Tubes* throughout the trains for various purposes. There is no difficulty in coupling them together between the carriages, except when they are required for steam from the engine at high pressure. The couplings then, besides becoming hot, are too delicate for the rough work of being constantly interfered with by the porters in the course of traffic. The waste of steam, also, both directly and from condensation, and the risk of accident to the porters in coupling and uncoupling, are amongst their disadvantages for such a purpose. The use of tubes for the conveyance of balls, numbered or lettered, by a direct current always passing from the passengers to the guard, and by a reversed current from the guard to the engine-driver, has been tested on the London and North-Western Railway. As originally devised, they necessitate the constant working of an air-pump in every break-van, which is open to the objections mentioned in No. 3; and no other satisfactory mode of obtaining the necessary current has been proposed. Tubes for the conveyance of sound, by whistle or otherwise, have not yet been properly tested, but the French Commission remarks with regard to them,—"Les n^os^ 17, 26, 28 et 29, croient à l'efficacité de tuyaux acoustiques communiquant sur toute la longeur du train. Il est facile de démontrer que ce système de communication serait au contraire entièrement inefficace."

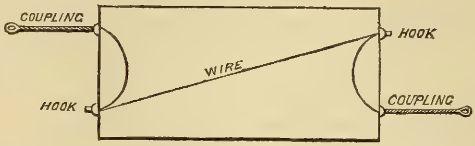
5. *Apparatus* worked by the *resistance of the atmosphere* during the passage of a train have hitherto proved, and are likely to prove, a failure, because the amount of resistance varies so much, according to circumstances, and the power obtained depends, not only on the speed of the train, but also upon the force and direction of the wind.

6. *Cords* or *wires* connected with whistles or bells on the engines or tenders. These have been extensively used both in this country and on the Continent as means of communication between the guards and engine-drivers, as well as in America, where they run along under the roofs of the carriages. They were recommended for adoption outside the carriages by the first sub-committee of railway managers, who reported in 1853, and they have since done good service, though they have been roughly applied, and have been known occasionally to fail in very long trains. They are not well adapted for further complication, such as connection with the several compartments of every carriage in a train, and a detector in each. Numerous projects of this sort have, however, been brought forward, and an attempt has been made to carry out one of them on the Great Northern Railway.

7. *Voltaic apparatus* appears, on the whole, to be the best adapted for complete inter-communication, though it has the disadvantage of being worked by batteries, which require to be examined—say once a month, and renewed—say every six months. The only arrangement that has yet, as far as we are aware, worked successfully upon a train on this (or any other) system, is by Messrs. Preece and Bedborough, on the London and South-Western Railway. The Exeter express train at 10.50 A.M. from the Waterloo terminus, now runs with it on Mon-

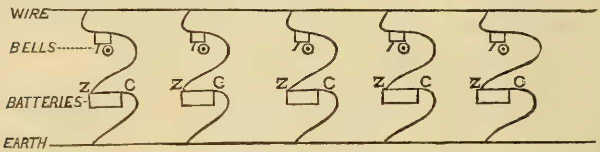
days, Wednesdays, and Fridays. Three trains, as well as all the state and saloon carriages of the company, have been supplied with it, and a fourth train is in hand. The voltaic circuit is carried through the trains by means of one wire under each vehicle, bifurcated as shown in Fig. 1, and connected with a coupling, and a coupling-

FIG. 1.



hook, at each end of each vehicle, to provide for its running in either direction, and to ensure more perfect action. The earth connection passes through the wheels, and the batteries and bells are so arranged —as shown in Fig. 2—that they are quiescent as long as the wire

FIG. 2.



is *clear*, but that if the wire be put "to earth" at any one point, every bell will ring throughout a train. The couplings between the carriages, which are shown in diagram 4* (Plate), have already been used for some time in France, on the Chemin-de-fer du Nord.

The coupling-hook (A) is of gun metal, and is kept from contact with a knob (B) of similar metal above it, as long as the eye (C) is upon it; but, as soon as the carriages become detached, the eye is pulled off the hook, the hook is forced up by the action of a self-contained spring against the knob, and the circuit being thus completed, the bells are rung throughout the train.

According to the latest modifications, there is no signal from the carriages either for day or for night, it being considered that whenever anything serious is the matter, the passengers will themselves direct attention to the carriage, in all cases in which no defect is visible to the servants of the company. Much expense is thus saved.

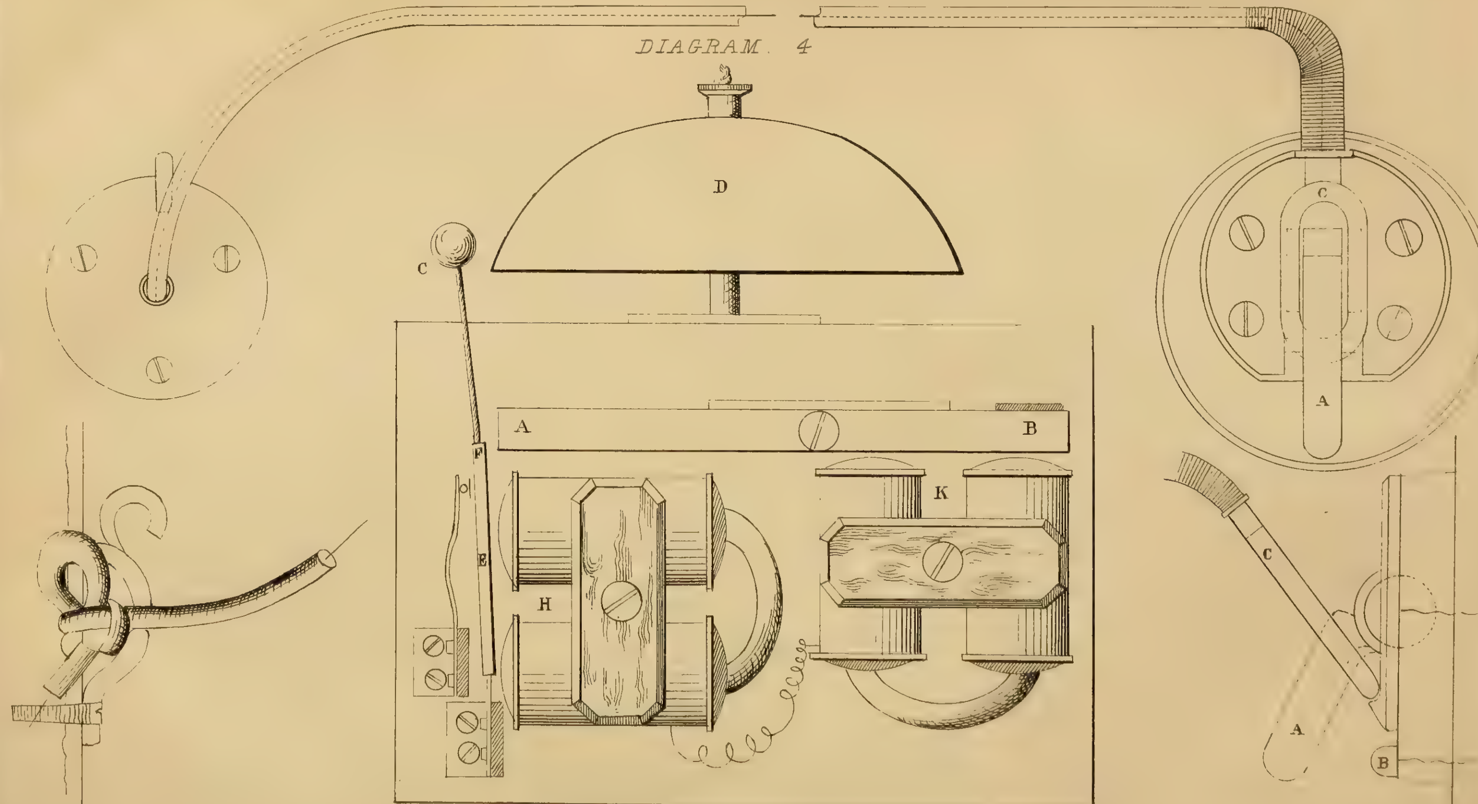
The bells in the guard's van and on the engine, are *trembling* bells, ringing incessantly as long as the current is maintained. The electro-magnet (H), acting upon the armature (E), causes the striker (C) to strike the gong (D) under the action of the current; and the bells

* This diagram has unfortunately been turned upside down by the lithographer, and the reader will therefore understand it better by reversing it.

PATENT ELECTRICAL COUPLINGS.

FOR RAILWAY CARRIAGES.

DIAGRAM. 4



ELEVATION OF ELECTRICAL BELL.

DIAGRAM No 5.

M & N Hanhart lith.

are prevented from ringing by the oscillation of the train, when the circuit is incomplete, by a simple and ingenious device. A stop-bar (A B), part of which forms the armature of a second electro-magnet (K), falls, and interposes (at F) to prevent the striker (C) from coming in contact with the gong (D) when the current ceases, and is lifted out of the way by the action of electro-magnet (K) upon armature (B) when the current passes.

The instrument to be acted upon by the passengers is simply a circular box affixed to the partition in each compartment of each carriage, with a convex glass face, covering a handle. In case of alarm, the passenger breaks the glass face, and moves the handle in the direction of an arrow. This completes the circuit and causes the bells to ring on the engine and in the guard's van, and they continue ringing until the apparatus is refixed by the guard. The fractured glass forms, of itself, an excellent detector. [The regulations which have been issued by the Company, being the first of the sort, are given in the Appendix.]

A young lady, Miss Gordon, of Prince's Gate, who has taken more pains in making herself thoroughly acquainted with the subject than almost any inventor of the stronger sex, has also proposed a system of voltaic communication through passenger trains. She has constructed a special train-telegraph coupling. She has designed a cheap form of telegraph-bell, intended, by repeated beats, either for making special signals, or for giving alarm signals; and she would employ it, not only for inter-communication in the trains, but also for communicating in cases of emergency between a train and the stations on either side of it. She further proposes, as an auxiliary to safety in some cases, to make each train record its movements past certain points, so that a fixed signalman may, as it were, watch its progress on a dial in his cabin long after it has passed out of his sight, or receive indication of its distant approach.

Whatever system may be used, it appears desirable that the handle, or button, or tassel, to be acted upon by the passengers, should be placed under glass; in order that it may not run any risk of being interfered with except in a case of necessity. An uncovered tassel or handle would be liable to be trifled with, and to be set in action thoughtlessly or unintentionally by a child, or too easily by a nervous passenger; whereas a glass, used as a cover, which could not be replaced, would only be broken under the pressure of considerable alarm. The keys of the doors of some of the French carriages have for years been placed in the compartments, protected in this manner, for the use of the passengers in case of necessity.

These questions of circulation and communication in trains have formed from time to time, as accidents have taken place or offences committed, a subject of recommendation by the Railway Commission and the Board of Trade, of discussion by Railway managers, of remonstrance by the public, and of projects by inventors, for the last twenty years. During that time circumstances have materially altered, but the want has become, upon the whole, more and more apparent. We are now labouring under great disadvantages, because the rolling

stock has hitherto been constructed independently on the different railways, without any provision for a suitable system; and the evil will, if it is unchecked, inevitably grow worse as years roll on. It is therefore desirable, that further delay should be avoided, and that measures should now be adopted for securing, within a reasonable time, the adoption of some general and appropriate remedy.

It cannot be expected that the directors or officers of railway companies, who are all under pressure, more or less, from their shareholders, should initiate such a remedy; nor can it be supposed that so many companies would all agree with one another as to what would be most expedient; but it is not probable, after all that has passed, and looking to the exigencies of the future, that the railway interest would combine seriously to oppose any well-considered scheme which might be proposed to Parliament. And indeed, the sub-committee of this year goes so far as to express an opinion "that it is desirable if practicable, to give passengers by express or other trains, running for a considerable distance without stopping, the means, in cases of emergency, of attracting the attention of the guard, and of enabling him to stop the train at the next station, or under the protection of the next fixed signals, and they recommend that no effort should be spared on the part of the railway companies to attain this object, it being borne in mind that, in order to give the public the full advantage of the communication upon the long through trains, many of which traverse several lines of railways, it is absolutely necessary that all the companies should adopt the same plan." We have, however, already explained why it is desirable that the engine-driver should have the advantage, as well as the guard, of hearing any signal that a passenger might make, not by any means as a direction to him to stop the train, but in order that he may be in a position to act for the best, according to circumstances, without loss of time, in a case of real emergency.

As a summary of what has been said, it would appear, upon the whole, to be desirable :—1. That no passenger vehicles should be constructed henceforward for railways except such as will afford the means of internal circulation through the trains. 2. That all existing passenger vehicles should also within some fixed number of years be made to afford internal circulation through the trains. 3. That all vehicles used in passenger trains should within some stated time be fitted with the means of voltaic communication, so that a passenger shall, in a case of emergency, have the power, from any compartment, of attracting the attention of the engine-driver and the guard or guards. 4. That any passenger wilfully and wrongfully making use of such communication shall be liable to a penalty on conviction.

It would serve no good purpose to enter further here into the details of such arrangements; but it may be added in conclusion, that the combined means of communication and circulation which are contemplated, would be principally deterrent as regards offences, from the comparative certainty of detection which they would afford; occasionally useful in preventing or alleviating the disastrous effects of accidents; and undoubtedly advantageous, both to the country and

to the railway companies, in affording increased confidence, and therefore promoting extra travelling, on the part of the public.

APPENDIX.

Copy of Instructions to Enginemen, Guards, and all Parties concerned on the South-Western Railway.

ELECTRIC COMMUNICATION BETWEEN PASSENGERS AND GUARD.

Some of the trains are now fitted up with an electric communication between passengers and guards. In the event of something of a *serious nature* occurring, which URGENTLY requires the stoppage of the train, the passenger may "break the glass," "and Ring" by moving the bell handle in the direction denoted by the arrow :—Thereby a bell will ring in each guard's van in the train, and also on the engine.

When the guards and enginemen hear the bell ring, they will at once *look carefully along each side of the train*, and in case any violent oscillation be seen, or a carriage be on fire, or other occurrence of a serious character be observed, *the train will be stopped* as speedily as possible, and, when stopped, must be protected by signals as prescribed by the Rule book.

Should, however, the guards and enginemen fail to observe anything *which really necessitates an immediate stoppage* of the train, their duty will be to stop the train at the next station or junction, so as to protect the train, when stopped, by fixed signals.

When the train is stopped the passenger who broke the glass and rang the bell will communicate with the guard; but should he fail to do so, the guard will detect the compartment from which the passenger gave the alarm by looking for the broken glass, and in case the alarm has been mischievously and wantonly given, or from insufficient cause, the names and addresses of all the passengers in that compartment will be taken, in order that the law may be enforced.

The Bell Signal Code between Guards and Enginemen is as follows:—

One Beat	Acknowledgment.
Two Beats	Go on; all right.
Three Beats	Look out; something wrong.
Four Beats	Shut off steam; pull up, and stop at next station or junction.
Six Beats	Danger; stop at once.

Every signal must be acknowledged. The acknowledgment by enginemen will be given by one whistle.

London, 10th August, 1865.

ON THE QUALITY OF MUSICAL SOUNDS.

By W. STEVENS SQUIRE, Ph.D., F.C.S.

THOUGH Music, as an art, is tolerably ancient, the investigation of the physical principles upon which it depends has only just commenced. There is, perhaps, no art in which physics come so much into play. With the exception of the human voice, which is itself the most delicately constructed instrument imaginable, nothing can be done in music without artificial apparatus, generally of a highly complex character, requiring as much skill on the part of the workman as the

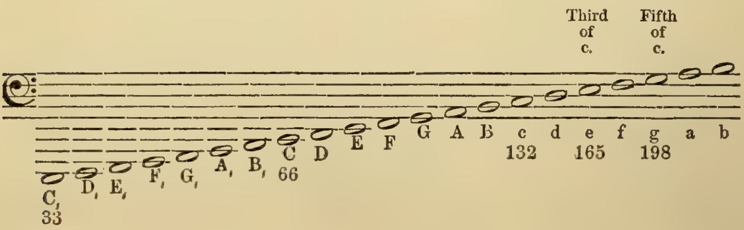
most delicate philosophical instrument. This apparatus is constructed with the greatest care, in order to produce certain musical effects which are characteristic of each kind of instrument, and the slightest uncertainty in the quality of the sound will make the difference between a good and bad instrument.

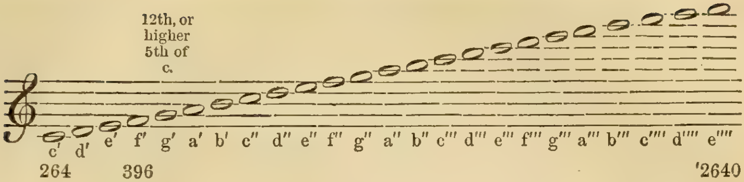
It would be supposed that the physical principles involved in so delicate a matter would be, to a certain extent at least, understood by the workman or the manufacturer, but, strange to say, this is not the case. Although the various musical instruments in use at present have been constantly improved until the quality of the sound leaves little to be desired, all this excellence appears to be the result of pure empiricism, of experiment, and of the rule of thumb. It is only in the last few years that any serious attempts have been made to ascertain on what the quality of sound depends, and, indeed, what it is that is meant by the term quality. Among these workers Professor Helmholtz, of Heidelberg, occupies the foremost place. He has been enabled, by means of peculiar apparatus devised by himself, to analyze various kinds of sounds, and to determine the nature of that property of sound which is called quality.

Musical sounds differ in pitch and in loudness. The pitch is regulated by the frequency, and the loudness by the extent, of the vibrations; but though the pitch and the loudness may be the same, the sound of a violin differs very greatly from that of the trumpet on the one hand, and from the flute or tuning-fork on the other; that is, though the same for musical purposes in all other respects, the quality is different.

The following tables will be found useful for indicating the number of vibrations requisite for, and the names of the notes in the musical scale, as it will frequently be necessary to mention them by name, and it would be inconvenient to have recourse to the staff:—

Notes.	C B	C B	c b	c′ b′	c″ b″	c‴ b‴	c⁗ b⁗
C	33	66	132	264	528	1056	2112
D	37·125	74·25	148·5	297	594	1188	2376
E	41·25	82·5	165	330	660	1320	2640
F	44	88	176	352	704	1408	2816
G	49·5	99	198	396	792	1584	3168
A	55	110	220	440	880	1760	3520
B	61·875	123·75	247·5	495	990	1980	3960





It is obvious from these tables, that if a vibrating body makes, for example, 132 oscillations per second, it will produce the note c, and, for anything that appears to the contrary, this effect is quite independent of the nature of the vibrating body; the greater or less violence of the vibration will merely affect its loudness, so that the simple undulatory theory of sound offers no explanation of what has hitherto been a mystery—its quality. This we must seek in some modification of the phenomenon. The table contemplates the case of a vibrating body; a string, for example, vibrating in regular periods in a pendulum-like way as a whole, and provided it does this in practice, it is clear that all sounds of similar pitch would be alike, whatever their source. But a closer examination of the vibrations of elastic bodies discloses some peculiarities of motion, which must seriously modify the effect. If we suppose a string stretched with a certain tension between two fixed points (A, B, Fig. 1), and that it is caused to vibrate as a whole, which may be done by plucking it at the

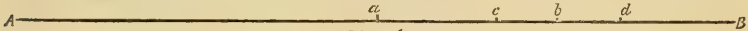


FIG. 1

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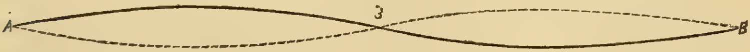

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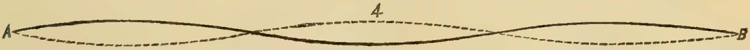

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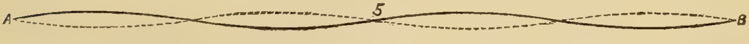

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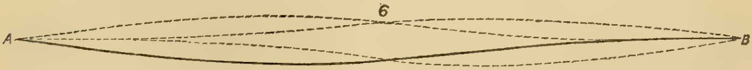


point *a*, it will vibrate as in Fig. 2, producing a certain note—say C. But if instead of plucking it at *a* the finger be gently laid on that

point and the string be plucked at *b*, and the finger immediately removed from *a*, the string will divide itself into two equal portions, each vibrating twice as fast as before, producing therefore the higher octave c, as in Fig. 3. If it be touched at *b* and plucked at *d* it divides itself into three portions, each moving three times as fast, and giving the twelfth of C, *viz.* g, Fig. 4, and so on for Fig. 5, which represents the second octave of C, c″. But the movement of a string is not limited to any single one of these forms of vibrations. It may partake of all or any; thus, a string may be divided into two, as in Fig. 2, and likewise vibrate as a whole, so that a phenomenon would be presented something like that shown in Fig. 6, where the string gives both the sound of C its fundamental tone, and also that of c, which is one of its upper tones.

In this case the node or fixed point *a* of the upper octave c is itself vibrating so as to produce C. It is obvious that the portions representing the higher octave may be themselves divided so as to produce the second octave c′, and the string would then simultaneously emit three sounds, C c and c′.

These secondary vibrations may vary much among themselves in intensity, that is, in their amplitude of oscillation, so that a string may give its fundamental note supplemented by upper tones, some of which will enter into the sound in greater strength than others, but as a rule those upper tones which lie nearest in the scale to the fundamental will be the most powerful, as they require a greater length of string and are therefore capable of oscillations of greater amplitude. But this is not always the case, the second, third, or fourth tone being sometimes more powerful than the fundamental itself.

This series of harmonic upper tones is always the same for all musical instruments, and is as follows:—

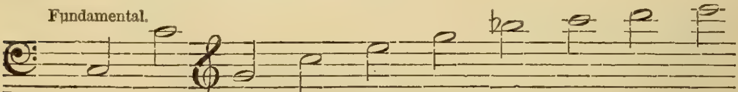
1st. The higher octave which makes twice as many vibrations as the fundamental note. If we suppose the key-note to be c, this higher octave would be c′.

2nd. The fifth of this higher octave g′, which makes nine times as many vibrations as c.

3rd. The second higher octave c″, which makes four times as many vibrations.

4th. The major third of the octave e″, with five times as many vibrations.

5th. The fifth of this octave, with six times as many, and so on to tones which require seven, eight, or nine times as many vibrations. Expressed in the musical scale, we have

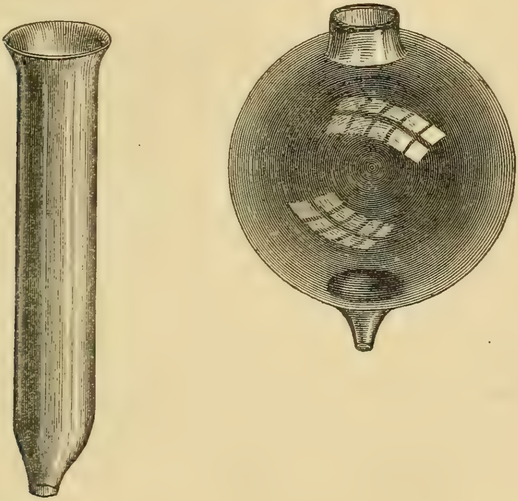


Tones	1	2	3	4	5	6	7	8	9	10
Vibrations—	66	132	198	264	330	396	462	528	594	660

It is not every ear that can, without great attention and practice, distinguish these upper tones in the sounds of musical instruments.

Still they had been observed long ago, particularly in the violin and violoncello, but were regarded as curious facts without any suspicion of their real importance. To distinguish them accurately and determine their intensity and pitch, requires an artificial help, which is supplied by the resonators of Helmholtz. These consist of glass globes, or very wide tubes, with an opening at each end, as in Fig. 7.

FIG. 7.



The smaller opening is made to fit accurately into the ear by means of a covering of sealing-wax, which is pressed while still warm into the opening of the ear, so as to take its exact form. Instruments of this kind possess the property of resounding and intensifying those sounds, and those sounds only, which are called forth by blowing across the wide opening. They are made of various sizes, each corresponding to a particular note in the scale. When one of these instruments is applied to the ear, and the other ear is perfectly closed, scarcely anything is heard of the external sounds, unless a sound be present of precisely that pitch which corresponds to the resonance of the globe when it bursts at once loudly on the ear. By means of this contrivance a complete analysis can be made of a mixed sound, resolving it into its fundamental and attendant train of upper tones.

It is to these secondary tones that we must ascribe what is called the peculiar quality of the sound. As they are present in greater or less proportion, so the sound is fuller or duller, just as a single note struck on a pianoforte is thin and poor, but is rich when supplemented by its chord, so the simple fundamental note is modified by the upper tones by which it is accompanied. Indeed the first six harmonic upper

tones must be looked upon from a musical point of view as a major chord in which the key-note is the most powerful. These upper tones may be either harmonic or inharmonic, harmonic if their vibrations are simple multiples of those of the fundamental, inharmonic when no such simple relation exists. There is scarcely any musical instrument which is free from these upper tones; the tuning-fork is nearly so, and those which are produced when the fork is first struck lie so far from the fundamental, that they speedily disappear and leave a perfectly simple sound as the characteristic of this instrument.

When a stream of air is directed across a wide tube, closed at the bottom and provided with a narrow opening at the top (such as a bottle), a tone is produced which is also free from upper tones. Again, by applying the handle of a tuning-fork to the end of a string so stretched as to be in perfect unison with it, the string takes up a pure pendulum-like vibration free from nodes, and gives also a simple sound. As might be expected from what has been said, these sounds, produced in three different ways and perfectly alike, are undistinguishable the one from the other. It is strictly true that could we eliminate altogether the upper tones of the various instruments used for musical purposes, they would all give nothing but the dull soft sound characteristic of the tuning-fork.

So long as the upper tones are harmonic to the fundamental they give it a peculiar rich quality by supporting it. As their vibrations are simple multiples of those of the fundamental, it is obvious that at certain regularly recurring intervals their vibration must be identical with that of the fundamental, so that like impulses applied at the proper moment to a swinging pendulum the action is increased and maintained. When the upper tones are inharmonic they give a peculiar piercing metallic character to the sounds, which is characteristic of instruments so situated.

The only cases in which the upper tones are strictly harmonic to the principal tone are vibrating strings and vibrating columns of air, and hence we find that musical instruments depend almost exclusively on these two means of producing sound.

Sounds produced in other ways are always accompanied by secondary inharmonic tones, and are only used by the musician when the fundamental is far more powerful than the secondary tones, in military and dance music, to mark the time or on account of their piercing quality. The tuning-fork itself is an instrument producing inharmonic upper tones, which are, however, so high and lie so far apart, and, moreover, are after a few moments so weak, that the principal tone is almost the only one which is appreciable. Vibrating bars of metal or other material are sometimes used in another form, either suspended perfectly free as in the triangle, or supported at the *nodes* of their principal tone as in the glass harmonicon.

Here the material of the bar has only just so much influence on the sound as depends upon its mass or elasticity. The high inharmonic tones will last longer in bodies of considerable mass and great elasticity, such as steel and certain alloys of copper; and on this account

these bodies produce a peculiar sharp, clear sound, which is aptly termed metallic. The quality of sound from glass is fuller and freer from the shrillness of the high upper tones, partly on account of its smaller mass and partly because it will not stand so hard a blow. Wood is still lighter, and is in its internal structure full of countless hollow spaces, and therefore of less elasticity, so that the secondary tones soon cease, and the sound is pleasanter to the musical ear. In all these cases hammers of cork or wood covered with leather are employed, for by these means the higher upper tones are rendered weaker than they would be with a metal hammer: but of this we shall speak more fully when considering the pianoforte. The vibrations of bars or metal discs and stretched membranes are capable of very exact mathematical calculation, but a consideration of these would lead us too far.

Metal discs are only used in the form of cymbals, which produce inharmonic upper tones of a very varied character, and bells may be considered also as belonging to this class, but the upper tones though inharmonious lie closer together. It is the great art of the bell-founder to render the lower upper tones as nearly as possible harmonic to the fundamental, which has been done by means of a peculiar form empirically discovered. By these means the tone of the bell is softened, but the precise theory of the form has yet to be worked out.

Of instruments with inharmonic upper tones we may say generally, that if these lie near in the musical scale to the fundamental the effect is to a high degree unmusical, bad, and kettle-like, as in cymbals. If, on the contrary, they lie tolerably wide, as in the tuning-fork, glass harmonicon, and bells (in which latter those which lie near to the fundamental are made harmonic), they may be used for marches, &c., but are rightly banished from classical music. Even if the harmonic upper tones disappear quickly they disturb the harmony exceedingly, so that the bell-playing of the Yorkshire ringers, who have attained to great proficiency, may be a curious but is by no means an agreeable performance.

Sounds with harmonic upper tones are produced in four ways: (1) By striking a string in a state of tension, or (2) by drawing a bow across it; (3) by setting a column of air in vibration by blowing against a sharp edge, or (4) by blowing against an elastic tongue (reeds). The instruments which belong to the first class are pianofortes, harps, and guitars, and we must also add the pizzicato of violins. The upper tones in the sound of an instrument of percussion depend upon—

1st. The kind of blow,
2nd. The place where the blow is delivered,
3rd. The thickness, rigidity, and elasticity of the string.

As far as the kind of blow is concerned, the string can either be drawn aside and then released, as in the harp or guitar; or by means of a plectrum, as in the ancient lyre and the modern Hungarian zitter; or the string may be struck with a hammer, as in the piano. It is easy at once to see that the effects will be very different. When

the string is drawn aside, the whole string is removed from its position of equilibrium, so that when it is released the vibration will be chiefly confined to the string as a whole, that is, the fundamental will far exceed in power the upper tones. If, on the contrary, the string is struck by a hammer which springs away immediately, it is only just that portion which was immediately in contact with the hammer that is set in motion.

Immediately after the blow, the other part of the string is at rest, and is only disturbed by the wave which is set up at the point of percussion, and which is propagated to the end of the string, and reflected back again like a wave on a trough of water, producing a long series of upper tones, the intensity of which may equal or even surpass that of the fundamental. The harder and lighter the hammer, the more quickly will it be thrown off, and the shorter will be the length of string displaced at the moment of impact, so that the fundamental might be quite inaudible, and the sound shrill, thin, and of disagreeable quality. To obviate this, it has been found advantageous to cover the hammers with soft felt. At the moment of first impact the felt is compressed so that the force is gradually applied, and it is only when a considerable length of the string is in motion that the whole of the force has been expended and the hammer thrown off. The thicker the felt and the heavier the hammer the longer will it remain in contact with the string; accordingly these conditions are observed in the lower octaves of the pianoforte, where the strings are long and heavy, and a proportionately greater mass must be set in motion in order to get rid of the high upper tones which would spoil the rich deep quality required. The time that the hammer is in contact with the string, to a great extent regulates the upper tones produced, for it is clear that there will be a tendency to produce just those tones which require an excursion of the string in one direction in the time, or in an even multiple of the time, that the hammer is pressing the string in one direction.

The place at which the blow is delivered exercises an important influence in this respect, as none of those tones which have a node (or place of rest) at this point can be produced. On the other hand, those which have their maximum of oscillation about this point will come prominently forward. Thus, if the string be struck exactly in the middle, the fundamental which has its greatest amplitude here will be most powerful, but the next octave will be wholly wanting the 12th, *i.e.* the 5th of the higher octave (the third tone) will be prominent, but the 2nd octave will not be produced, that is, the tones of the even numbers will be absent, but those of the uneven numbers will be present. The effect of this is to give the sound a dull nasal character. Now the first six tones come exactly into what is called the major chord, that is, they are all thirds, fifths, and octaves, but the seventh tone, which is a minor seventh, and the ninth, which is a minor second, do not come into the chord. Theory, therefore, indicates that the place at which the string should be struck is that at which these tones have a node. Such a point is situated about the seventh from the end of the string, and this is the place actually

adopted by the manufacturers. No theory has led them to this, but by blind experimenting they have arrived at the same practical conclusion that theory points out.

Lastly, the thickness and material of the strings have considerable influence on the quality of the sound, for very stiff strings cannot give such high upper tones as thinner ones, because they are not capable of subdividing themselves into such minute flexible portions. With a very thin wire, such as is used for artificial flower-making, it is possible to obtain the 18th tone if the string is 7 or 8 yards long, but these high tones no longer belong to the major chord, and produce that peculiar wiry tone characteristic of instruments such as the zitter, with very thin wires. The elasticity of gut strings is far less than that of wires of similar thickness, so that the high upper tones disappear at once, and the sound is fuller and rounder.

The theory of fiddles is not so complete as that of the piano, as the peculiar action of the bow, which is not well understood, will greatly influence the quality of the sound. The string is drawn by the friction of the bow from its position of equilibrium, and as soon as the tension overcomes the friction it is suddenly released, so that the motion rather resembles that of a tilt hammer, slow in the one direction, but quick in the other. The fundamental is proportionately stronger in these instruments than in those in which the string is struck near the end, as in guitars and pianos, the lower upper tones are weaker, but the higher tones, from the sixth to about the tenth, are much more distinct, and to these are due the peculiar clearness of the sound. The form of the vibration is in the main tolerably independent of the place where the bow is used, still minute variations arise from this cause. If, for example, the bow is drawn across a portion of the string which corresponds with a node of one of the higher tones, that tone will be wanting, and variations in the quality are partly dependent on this circumstance. So that if the bow is used too near the finger board, the end of which is about one-fifth of the length of the string from the bridge, the fifth or sixth tone will be absent, which ought otherwise to be audible, and the sound will be duller. The usual position of the bow is about one-tenth from the bridge, for piano passages rather farther, for forte rather nearer. If the bow is used very near the bridge, about one-twentieth, it is possible to produce by a gentle and rapid movement only the higher octave, so that a node is produced in the middle of the string, just as if it had been lightly touched by the finger at that point, and between this point and the usual place every possible mixture of the primary tone and its higher octave may be obtained.

In the quality of the tone of the violin, much is supposed to depend upon the wood of which it is made, and this is unquestionably true. Still both age and long use of the instrument tend to increase the elasticity of the wood, which is, perhaps, one reason for the preference accorded to the instruments of the old makers. The sound of the violin does not come to us direct from the strings, but from the body of the instrument. The one leg of the bridge rests on a rod of wood joining the upper and lower surface, the other rests

unsupported on the upper wooden surface, and this conveys to it the vibrations of the strings, which are again transmitted to the air by the greater surface of the wood. But a hollow space enclosed by elastic walls like those of the violin must have certain proper tones which may be evoked by blowing into the openings. Savart found this to be for the violin c′ and for the violoncello F. This will have the effect of strengthening those tones which approximate to those of the hollow space, and it is found both in the violin and violoncello that these tones come broadly out. As the lowest note of a violin is g, it is only the upper tones of the three lowest notes which will be increased by resonance, while of the other notes generally, the fundamental will be augmented rather than the upper tones, as they approximate more to the peculiar tone of the body of the instrument.

The pipes of an organ consist of two parts, a sharp edge against which a current of air is driven, and a hollow pipe which may be either closed or open at the top. These pipes act in a similar way to the resonators of Helmholtz. The air when driven against the sharp edge, produces a kind of whistling hissing noise, which consists of unharmonic tones lying tolerably close together. The pipe itself is capable of strengthing, by its resonance, just those tones and those only which are either its fundamental or its harmonic upper tones. All other sounds remain unaffected, and are almost completely masked by the increased power of those fortified by the pipe. By blowing very hard the pitch of the noise is raised and the fundamental may disappear, and only the upper tones remain. A flute is in precisely the same predicament as an organ pipe—certain tones produced in the noise made by blowing across the holes are strengthened by the tube, which may be made shorter or longer by closing the holes. A flute, when gently blown with all the holes closed, gives d′, by stronger blowing d″, by still stronger a″, or even d‴—the series of harmonic upper tones of d′. In those parts of the organ consisting of narrow cylindrical pipes the fundamentals are accompanied by very clear powerful upper tones, which produce that sharp fiddle-like character of the Viola di Gamba and other stops; by the help of the resonators the sixth upper tone may be clearly distinguished, a tone which is also very powerful in the fiddles themselves. In the wide pipes there is far less tendency to fortify the higher upper tones, so that these pipes will bear much harder blowing than the narrow ones without starting into upper tones, and on this account, and because the vibrating mass of air is large, they are used to produce the chief volume of sound, and are called principals. In the wooden principals the second tone (the octave) is easily recognized, the third (the higher fifth) is weak, and the still higher ones are no longer audible. In the metallic principals they are found as high as the fourth tone. The quality of tone in these pipes is fuller and softer and less shrill than in the narrow ones (violin principals). By narrowing the upper end of the tubes the fifth and seventh tones become more prominent, and the sound is on this account thin, but clear and brilliant. The narrow closed pipes are characterized by

the higher tones of the *uneven* numbers—the third, fifth, and seventh upper tones. The wide closed pipes are almost free from any upper tones whatever, so that the quality will resemble that of the tuning-fork. Sometimes a small tube open at both ends is inserted into the cover of a closed pipe, and it is of such a length that its proper tone corresponds to one of the upper tones (generally the fifth) of the closed pipes, so that the sound acquires a peculiar clearness. The absence of the upper tones of the even numbers gives the sound of closed pipes a certain dullness in comparison with that of open ones, but they form an excellent contrast to the shrillness of the latter.

The sides of wooden pipes are not so well fitted as those of metal ones to resist the vibrations of the air, and the higher tones are therefore quickly extinguished, so that the sound of these pipes is always somewhat dull.

In the so-called reed pipes the noise, to be purified and strengthened by the pipe, is produced by the vibrations of a tongue of metal or wood vibrating in a slit, which it closes or nearly so. When set in motion by air blown through the slit, it admits at each vibration a puff so as to produce a series of periodic impulses, which, acting on the column of air in the pipes, sets it in a state of vibration. In the organ and harmonium these reeds are of metal; in the oboe and clarinet, of wood. A similar arrangement may be produced by the use of elastic membranes stretched across an opening, closing it when at rest, but during the passage of a current of air they are forced asunder, and again return to close it by their elasticity. This arrangement occurs in practical music in two forms—in human lips when blowing brass instruments, and in the larynx when singing. The lips may be regarded as very slightly elastic membranous bodies, heavily weighted with unelastic tissue, which by themselves would vibrate very slowly, but used together as a means of producing a series of puffs they are capable of producing a tolerably high tone. The vocal chords are similar, but they have this great advantage over all other reed instruments: that the opening of the slit, the tension, and even the form, can be altered at will with great rapidity and precision. In addition to this the form of the resonance tube, which is here represented by the cavity of the mouth, can be changed so as to produce a greater variety of sounds than any other instrument. The metal reeds of the organ and harmonium are only intended to produce a note of a certain fixed pitch. On these heavy and rigid reeds the vibrating column of air in the pipe has but little reciprocating influence, and such instruments must have a separate reed for every pipe. In the wooden reed instrument there is but one reed, which must serve for the whole series of notes. These reeds are made of a light, elastic wood, and from their lightness they are themselves affected by the vibrations of air they have set up in the tube. They are capable not only of giving the high notes corresponding to the periodicity of the reeds, but also of exciting much lower notes when the tube is lengthened by closing the holes. Under these circumstances the vibrations are sufficiently powerful to carry the reed with them, and the pitch is regulated by the length of the tube, and not by the oscillations of the

reed. The clarinet has a cylindrical tube, which is practically closed at the top, and it is subject to the same laws which regulate vibrations in closed organ pipes; that is, the upper tones of the even numbers are wanting, so that by blowing strongly the pitch may be raised a twelfth, but not an octave, as in the flute, because the octave is a tone of the even numbers. The tube of the oboe is conical, and conical tubes closed at the point have nearly the same peculiarities as open pipes of the same length; accordingly we find in this instrument the whole series of upper tones.

The older horns and trumpets consisted of long conical brass tubes without valves of any kind. From such an instrument, it was only possible to elicit the harmonic upper tones of its fundamental, but as the principal tone of so long a tube is very deep, the upper tones in the middle of the scale would lie pretty near together, and most of the notes in the scale can be obtained. The trumpet was confined to these, such as they were, but in the trombone, by altering the length of the tube, the wanting notes can be supplied, and the faulty ones improved. Of late years valves have been used for a similar purpose, both in horns and trumpets, but at the cost of the power and quality of the tone. In using these instruments, the form and tension of the lips is only of importance to determine which of the harmonic sounds of the column of air is to be produced, the absolute pitch is quite independent of them.

In the human larynx, however, the tension of the vocal chords directly alters and determines the pitch. The hollow space of the mouth is not fitted to fulfil this duty. Its walls are too yielding to maintain a vibration of air sufficiently strong to carry with it the reed as in the trumpet or clarinet, moreover it is too short to have much influence on the pitch. Besides altering the tension of the chords, there is probably a power of weighting them with the moist unelastic tissue which lies immediately beneath them, so as to produce the lower notes of the chest voice.

The quality of the sound emitted by reeds unconnected with resonance tubes is very sharp and harsh, due to a long series of upper tones extending as high as the sixteenth or twentieth. The harder the material of the reed the greater the number of dissonant sounds produced, and it is probably due to the softness of the vocal chords that a good human voice is the pleasantest of all the reed instruments. Even in the voice we find very high upper tones, as high as the fourth octave. The resonance tubes modify the sound most essentially. They respond only to those sounds which are the proper tones of the tube. The clarinet, which must be regarded as a closed cylindrical pipe, gives only the upper tones of the uneven numbers, while the oboe, the tube of which is conical, gives those of the even numbers also. This is the cause of the difference in the quality of the sound of these two instruments, in both of which the sound is produced by the agency of a wooden reed.

So far we have considered the case of resonance tubes which are able to give the fundamental of the reed, and also a series of upper tones, but it may happen that the lowest tone of the resonance tube is

not the fundamental of the reed, but one of its upper tones. Under these circumstances this particular upper tone will be prominently strengthened, and the sound will acquire a peculiar character resembling more or less the vowels of the human voice. In fact, the vowels are sounds produced by membranous reeds—the vocal chords, the resonance tube of which—the cavity of the mouth, can be so modified in width, length, and form as to fortify sometimes this, sometimes that, upper tone of the sound. The easiest and surest way of determining the proper tone which corresponds to the position of the mouth for each vowel is to gently whisper any vowel, retain the mouth fixed in that position, and test it by holding before it tuning-forks of various pitch until one is found, the sound of which is intensified by the resonance of the mouth. By passing in this way from one vowel to another, the tones peculiar to each position of the mouth may be ascertained. The determinations given below are those of Helmholtz, and apply to the vowels pronounced in the German way. Both for O and for U the opening of the mouth is narrowed by the lips, while the greatest possible space is given in the middle by drawing down the tongue, so that the mouth approximates to the form of a bottle with no neck. In such bottles the smaller the opening the lower the tone. This is borne out by these vowels. For U, in which the opening is the smallest and the space the largest, the proper tone is found to be f, and when the U is gradually converted into O by opening the mouth the resonance rises also, until for a pure O the proper tone of the mouth becomes b′ flat. The position of the mouth for O is particularly favourable for resonance, the opening being neither too large nor too small, and the hollows sufficiently large. If a fork which is tuned to b′ flat is struck and placed before the mouth while the vowel O is gently whispered, the sound of the fork becomes so full and loud that it can be heard by a large audience, but if the position of the mouth is now changed through Œ and Æ to A (as in father) the resonance rises a whole octave to b″-flat. The sharper English and Italian A rises to d″, that is, a third higher. For these vowels there appears to be only one peculiar tone, and the theory of sounds produced in spaces of this shape would not lead us to expect otherwise. Starting once more from A through the series A, Æ, E, I, we find that the lips are so far drawn back as not themselves to produce a narrowing, but that a narrowing of a different kind is effected by the front part of the tongue and the hard gums, while the space over the larynx is widened by drawing in the root of the tongue. The form of the mouth is now that of a bottle with a narrow neck produced by the upper surface of the tongue and the gum. For * I the hollow of the bottle is the largest, and the neck the smallest. For Æ the whole channel is rather wide. When these positions are tested two tones may be distinctly detected, the one corresponding to the large space, the other to the narrow tube-like passage between the gum and the tongue, so that the whole arrangement resembles in principle the organ pipes already described, in

* I pronounced rather like the English E, and the E like a flat A.

which a small narrow tube is fixed into the closed top of the pipe. This condition is most prominent for I where the length of the small canal is about two inches.. Such a pipe would give the sound c^{iv}. The tone really found to be produced is d^{iv}, which is pretty near the mark if we take into account the irregular form of the tube. These vowels, then, are distinguished by two tones, the higher of which continues the series of the vowels U, O, A. Helmholtz has found them to be for Æ, g'''; and for E, b'''-flat; and for I, d^{iv}. The lower tones, which are more difficult to determine, he found to be for Æ, d''; and for E, f'; and for I, f. In producing the vowels Œ and UE the position is much the same as for the last, except that the lips come into play and lengthen as well as they can the small tube, thus lowering its pitch. For UE, its length will be about $2\frac{3}{4}$ inches, and the tone is found to be g'''. The lower tones are for Œ, f'; for UE, f. The following scheme exhibits the resonance of the mouth for each vowel:—

Hence we may conclude, and the supposition is borne out in practice, that certain vowels will sound better than others in particular parts of the scale, and they do so whenever their characteristic note is one of the harmonics of the note sung. U sounds in men's voices best on f, its characteristic note, or on d, or the lower octave F; the vowel E best on f', or the harmonic under-tones f, or B, and so on. And this is particularly observable at or about the limits of the voice. Female voices have a tendency under c' to run into a dull O or O U, whose proper tone is situated here. In their higher note above e'' or f'', the vowel A sounds best, as its proper tone is at b''-flat and above b''-flat I.

From the foregoing considerations we may deduce the following principles:—

That what is called the quality of sound is an apparent rather than a real phenomenon.

That pure sounds, however produced, sound alike soft and pleasant, but dull and of little power.

That a difference in their quality is only produced when to the simple sounds are added one or more sounds of a higher or lower pitch; and it is the mixture of simple sounds in various proportions that produces what is called the special quality of the sound emitted from different instruments.

That sounds which are accompanied by their lower upper tones about as far as the sixth are fuller and richer than simple sounds, but are still soft, provided the higher upper tones are wanting. Under

this head we must class the pianoforte, the open organ pipes, the softer tones of the human voice, and the horn, which latter forms the link which connects these with instruments with high upper tones.

Flutes and the wide closed organ pipes approach nearly to the simple sounds.

That when only the upper tones of the uneven numbers are present, as in the narrow closed organ pipes, strings struck in the middle, and in the clarinet, the sound has a hollow, and if the upper tones are very numerous, a positively nasal character. When the fundamental is predominant the sound is full, but if it is deficient it is thin. On this account the sound of wide open pipes is fuller than that of narrow ones, and the sound of strings struck with a soft hammer, than those struck by a hard one, and the tone of reeds with a resonance tube richer than that of reeds not so furnished. When the upper tones beyond the sixteenth or seventeenth are perceptible the sound is sharp and rough, on account of the discord of the higher tones. The degree of sharpness may vary, if slight it does not prevent the use of such instruments in music. Under this head come fiddles, most reed pipes, the oboe, harmonium, and human voice. These dissonant upper tones are far more prominent in the brass instruments, and they can scarcely be used alone for classical music, but they are of value on certain occasions for their great power in the orchestra.

THE MAMMALS OF SOUTH AMERICA.

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(*With a Plate by Wolf.*)

THE Zoological differences between the Old and New Worlds have been well known to naturalists since the time of Buffon, whose theory it was that the animals of America were degraded descendants of those of the Eastern Hemisphere. While there is, no doubt, some sort of truth in this idea—for, where corresponding forms occur, the American is usually less in bulk and feebler in its distinctive characters than its representative in the Old World—it will be better, if we wish to gain a correct view of the Zoology of America, to dismiss altogether from our minds any idea of parallelism between the two Faunas. The northern portion of the Western Hemisphere is, it is true, overrun by Palæarctic forms, which have extended themselves southwards, in some cases even beyond the isthmus of Tehuantepec. But the great southern mass of the New World has been almost undisturbed by these northern invaders, and in every branch of Zoology—particularly among the Mammals—presents us with such a number of peculiar types, as to render the South American or Neotropical Region, after Australia, the most distinct of any of the great Zoological divisions of the world's surface.

In the present endeavour to put forward the general aspects of the Mammal-fauna of this region in a somewhat more decided light than has yet been attempted, I shall proceed to discuss the forms of the different orders of terrestrial Mammals that are found within its area, one by one. Summarizing the results thus arrived at, we shall not find it difficult to realize the principal characteristic features of Neotropical Zoology as regards this order of Vertebrates.

The American Monkeys, as universally allowed by Zoologists, form a strongly-marked division of the order Quadrumana, so distinct from the corresponding forms of the Eastern Hemisphere as not to be possibly confounded with them. They are spread over nearly the whole of tropical America, on the eastern side of the Andes, from the tierra caliente of Southern Mexico* to the most southern woodlands of Brazil and Uruguay. To the west of the Andes I am not aware that the presence of Quadrumana anywhere south of the Bay of Guyaquil has yet been recorded. The American Quadrumana are divisible into two well-marked sections, which perhaps deserve the rank of families. The Cebidæ, which are the most highly organized of the two divisions, are at once distinguishable from the Simiidæ of the corresponding latitudes of Africa and Asia by the presence of thirty-six teeth, instead of thirty-two; the false molars being increased from eight to twelve in number. The Marmosets (Hapalidæ), which take a lower rank, have the same total number of teeth as the Old World Simiidæ, but four fewer true molars, this difference being made up by a proportionate increase in the number of false molars—which, as in the Cebidæ, are twelve in number. The subjoined table will give at a glance the distribution of the generally-recognized families of the Quadrumana amongst the seven principal Zoological Regions of the earth's surface.

1. Neotropical Region.	2. Nearctic Region.	3. Palæarctic Region.	4. Æthiopian Region.	5.† Lemurian Region.	6. Indian Region.	7. Australian Region.
Cebidæ Hapalidæ		Simiidæ	Simiidæ* Lemuridæ	Lemuridæ Chiromyidæ	Simiidæ Lemuridæ Tarsiidæ	

A few words may now be said concerning the principal genera which compose the two families of American Quadrumana. It may be

* For some remarks on the northern limit of the Quadrumana in the New World, see 'Nat. Hist. Rev.,' 1861, p. 507, where I have endeavoured to show where the line should be drawn with more exactitude than has hitherto been done.

† I have hitherto only reckoned the principal Zoological Regions of the earth, as *six* in number, having associated Madagascar and its islands with Africa. The peculiarities of the Zoology of Madagascar and the Mascarene Islands are, however, so great, especially as regards its Mammals (see my former article on this subject, 'Journ. of Sc.,' vol. i. p. 213), that it is perhaps better to consider them as forming a distinct Zoological Region, for which no term can be more appropriate than that of *Lemuria*, as has been already suggested *l. c.*

remarked that the American Monkeys, are, without exception, exclusively *arboreal* in their habits. Some of the Old World members of the order, such as the Formosan Macaque (*Macacus cyclopis*, Swinhoe),* and the Barbary Ape (*Macacus Sylvanus*), are rather rock-climbers than tree-livers. But this is not the case with any species of the two American families of Quadrumana, as far as has been hitherto recorded. Commencing the series with these forms of the Cebidæ, wherein the possession of a fifth hand, in the shape of a prehensile tail, shows a more especial adaptation to tree-life, we first meet with the genera *Mycetes*,† *Lagothrix*, *Brachyteles*, and *Ateles*. In these forms the terminal vertebræ of the tail are dilated, and its extremity is denuded of hair on the under side, so as to permit of a firmer hold being taken by this organ, and to render it still more available for locomotion. Of the *Mycetæ*, or Howling Monkeys, so remarkable for the terrific bellowings which they are enabled to produce by a special modification of the hyoid bone and thyroid cartilage, about six species are generally recognized by naturalists. These range over nearly the whole of the limits within which the American Quadrumana are distributed, at any rate from Guatemala to Southern Brazil. *Lagothrix*, on the other hand, is a form confined to the valley of the Upper Amazon. Though several species of this genus have been described, it is probable that they may be all referable to varieties of the *Lagothrix Humboldtii*.‡ The genus *Brachyteles* of Spix (= *Eriodes* of Isidore Geoffroy St. Hilaire) is another monotypic form, peculiar to the forests of S.E. Brazil. Although nearly allied to *Ateles*, it is distinguishable by "the peculiar position of the nostrils, the equality in size of the incisors, the shortness of the canines, and the globular form of the head." § *Ateles*, on the other hand, is more numerous in species, and more widely diffused, the most northern monkey hitherto recorded in the New World belonging to this genus,‖ and the group being represented also in Southern Brazil. About seven or eight species of *Ateles* appear to rest on good authority, and are usually recognized. They are all remarkable for their long slender bodies and elongated limbs, whence they have obtained the appropriate name of Spider Monkeys. They are also distinguishable by the absence or imperfection of the thumb, a structure which, singularly enough, likewise occurs in a genus of Simiidæ (*Colobus*) met with in the corresponding latitudes of the African continent.

* 'Proc. Zool. Soc.,' 1812, p. 350.

† *Mycetes* is usually arranged in this neighbourhood, but Mr. Flower has recently shown ('P. Z. S.,' 1864, p. 338) that, as regards its brain-structure, it departs widely from *Cebus* and the more highly-organized Platyrhines, and appears to be more closely allied to *Nyctopithecus*. The structure of its sternum is also abnormal.

‡ Cf. Bates' 'Naturalist on the Amazon,' ii. p. 319; and Slack in 'Journ. Acad. Phil.,' 1862, p. 515.

§ Slack, 'Proc. Acad. Phil.,' 1862, p. 513.

‖ See 'Nat. Hist. Rev.,' 1861, p. 508.

Next to these four genera we must arrange the typical form *Cebus*, in which the tail, though still prehensile and having the terminal vertebræ dilated, is wholly covered with hair, and does not serve the same important office of a fifth hand, as is the case in the Ateline groups. The *Cebi* have a wide range, from Guatemala on the north, to the banks of the Uruguay in the south. They are very difficult to distinguish specifically, owing to their great variation in colouring. Wagner, in his supplemental volume to Schreber's Sängethiere, reduces the species of this genus to ten, while Reichenbach, in his lately published Natural History of Apes,* recognizes not less than thirty-five! There can be no doubt that of the two Wagner is much nearest to the mark.

After *Cebus* we come to a section in which the tail is lax and villous throughout, and no longer used for prehension. This group embraces the insect-eating genera *Nyctipithecus*, *Callithrix*, and *Chrysothrix*. *Nyctipithecus* contains some three or four species from the great wood region of the interior of South America, remarkable for their owl-like physiognomy and nocturnal habits. *Callithrix* is a more numerous genus, and rather wider in its distribution, *Callithrix personata* being said to occur on the banks of the river Parana, north of Corrientes, and two or three other species, besides this, being found in South-eastern Brazil. *Chrysothrix* embraces three species, two from the Amazon valley, and a third (*C. sciurea*) from Guiana and Venezuela, but extending up the Panamanic Isthmus as far north as David.†

All the preceding genera of American Quadrumana have vertical incisors like the Monkeys of the Old World. There remain to be noticed two forms belonging to the Cebidæ, peculiar for having their incisors sloping forward like some of the Lemuridæ. These are *Pithecia* and *Brachyurus*. The Sakis (*Pithecia*) number some seven or eight species, which inhabit various parts of the great Amazonian wood region and Guiana. *Brachyurus*, distinguished from *Pithecia* by its abbreviated tail, contains four species, all from the forests of Amazonia.

The second family of the American Quadrumana, the Hapalidæ (Marmosets), comprehends about thirty species, divisible into two genera, *Hapale* and *Midas*. They are most numerous in the forests of the interior of South America, ranging as far south as the borders of the Argentine Republic. One species (*Hapale œdipus*) is common in Chiriqui, Central America, but I am not aware that any member of this family has been known to occur farther north.

In considering the Neotropical forms of the next great order of Mammals, the Chiroptera, I shall follow strictly the new classification of this group lately proposed by my friend Dr. Peters, of Berlin,‡ who has devoted so much time and attention to the study of this diffi-

* Die Vollständigste Naturgeschichte der Affen. Dresden.

† See 'Proc. Zool. Soc.,' 1856, p. 139.

‡ 'Sitzungsb. Ak. Wiss. Berl.,' 1864, p. 256.

cult order. Dr. Peters divides the Chiroptera into seven families, of which the subjoined table shows the geographical distribution :—*

1. NEOTROPICAL REGION.	2. NEARCTIC REGION.	3. PALÆARCTIC REGION.	4. ÆTHIOPIAN REGION.	5. LEMURIAN REGION.	6. INDIAN REGION.	7. AUSTRALIAN REGION.
			Pteropodidæ	Pteropodidæ	Pteropodidæ	Pteropodidæ
			Megadermatidæ		Megadermatidæ	Megadermatidæ
		Rhinolophidæ	Rhinolophidæ	Rhinolophidæ	Rhinolophidæ	Rhinolophidæ
Phyllostomatidæ	Phyllostomatidæ					
Noctilionidæ			Noctilionidæ		Noctilionidæ	Noctilionidæ
Molossidæ		Molossidæ	Molossidæ	Molossidæ	Molossidæ	Molossidæ
Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ	Vespertilionidæ

It will be observed that the true frugivorous bats, forming the family Pterpodidæ, which on account of their three-jointed index-finger and peculiar dentition are often regarded as constituting a separate sub-order of the Chiroptera, are altogether wanting in the New World, their place in the economy of nature being taken by certain forms of the more typical Chiroptera, the structure of which is so modified as to enable them to perform the same functions. So, likewise, are the two first families of the Insectivorous section. In the third family the Phyllostomatidæ, or Vampires, we have a group purely American, and, indeed, forming one of the most characteristic features of the Neotropical Fauna, as they are nearly entirely confined to the Neotropical area, only one or two species wandering beyond its limits into the neighbouring parts of the northern region of the New World.

The Phyllostomatidæ form one of the three families of Insectivorous Bats which are provided with a peculiar dermal development on the upper surface of the nose. From the Leaf-nosed Bats of the Old World (Megadermatidæ and Rhinolophidæ) the Phyllostomatidæ are at once distinguishable by having *three*, instead of *two*, bony phalanges in the middle finger. With the exception of the genus *Macrotus* the ears generally stand asunder from one another, as in our Horseshoe Bats (*Rhinolophus*), but they are always provided with an "ear-clapper" or tragus, placed in front of the aural orifice, which is wanting in the *Rhinolophi*. They are divided by Dr. Peters into five sub-families, concerning which we may say a few words.

The typical Phyllostomatidæ or *Vampyri* of Dr. Peters contain the genera *Phyllostoma*, *Vampyrus*, *Carollia*, and *Macrotus*. They are insectivorous, although the large *Vampyrus spectrum* has been stated, upon what is apparently good evidence, to be addicted to blood-sucking, like the true Desmodinæ. The second sub-family (Glossophagina), comprehending genera with an elongated snout and a long producible and sharp-pointed tongue, is also insectivorous. The next sub-family (Stenodermatina) contains only frugivorous bats, much like the Vampires in external appearance, but with teeth-characters modified to suit their diet. The fourth sub-family, as arranged by Dr. Peters,

* In accordance with the convenient (though not strictly classical) system generally adopted in this country, I have so far modified Dr. Peters' family names as to bring them all to a uniform termination in *idæ*.

contains only the two very peculiar genera *Desmodus* and *Diphylla*, wherein the teeth are expressly modified into an instrument for tapping the blood of other Mammals. In the young *Desmodus* six upper incisors are present; in the adult animal the two outer pairs disappear to make room for the highly-developed medial pair, the inner margins of which meet together and form a most formidable weapon for blood-letting. True molars are wanting altogether in this form of bats, as they have no occasion to masticate their food. The stomach of *Desmodus* also presents a most remarkable structure, which has lately been described by Professor Huxley,* and is clearly connected with its abnormal diet. The cardiac end of this organ assumes the form of an elongated cæcum reflexed upon itself, and is evidently intended to form a reservoir for the blood drained by the *Desmodus* from the body of its victim.

Whatever may be the case with regard to the other Vampires, we have the most unquestionable evidence as to the blood-sucking habits of the genus *Desmodus*, Mr. Darwin having been present when, in the neighbourhood of Coquimbo, in Chili, one of his servants captured a bat of this form actually fastened upon a horse's back. As regards its ally *Diphylla*, we have similar testimony from Mr. Fraser, who sent home from Ecuador an example of *D. ecaudata* taken in the act of sucking blood from a man.† The fifth and last sub-family of the Phyllostomatidæ consists of *Mormops*, *Chilonycteris*, and the allied form *Pteronotus*, three genera of which the principal sedes is the West Indian Islands, although some of the species penetrate into the adjoining parts of the continent. They are remarkable for having the end of the tail free, and extended from the back of the caudal membrane.

We now come to the Insectivorous Bats, without any foliaceous appendage to the nose. These are divided by Dr. Peters into three families, each of which has three representatives in South America. Of the Brachyura or Noctilionidæ, as we should prefer to call them, distinguished by the abbreviated tail, which is shorter than the anal membranes, four well-marked genera are met with in this region. The most remarkable of them, and one of the most curious forms in the whole series of Chiroptera, is *Diclidurus*, in which the terminal caudal vertebræ are so modified as somewhat to resemble a bell. The single known species of this form, which is of rare occurrence, has been obtained in Brazil and in Central America. It is, moreover, remarkable for the colour of its fur, which is nearly white—a most unusual character amongst the Mammals of tropical regions.

The Molossidæ, with their long rat-like tails and swollen lips, are represented in America by species of the genera *Molossus* and *Nyctinomus*, the former, as restricted by Dr. Peters, being peculiar to the tropics of America. The typical and very numerous family, Vespertilionidæ, is of universal distribution, but presents us with

* "On the Structure of the Stomach in *Desmodus rufus*." By Professor T. H. Huxley. 'Proc. Zool. Soc.,' 1865, p. 386.

† See 'Proc. Zool. Soc.,' 1860, p. 212.

several purely Neotropical forms, such as *Histiotus*, *Natalus*, and *Thyroptera*.

The third great order of Mammals, the Insectivora, are, as far as our present knowledge extends, entirely wanting over the whole of the continental portion of America south of Panama. The Arctopolitan* genus *Sorex* descends into Central America as far south as Guatemala, where a single species was collected by Mr. Salvin.† Other Shrews are registered in Dr. Gray's Catalogue of the Mammals in the British Museum as having been obtained at Coban, in the same country. But farther south every trace of the Insectivora disappears, and their place in the economy of nature is probably supplied by the entomophagous Marmosets, and by the numerous small species of Marsupials belonging to the family Didelphyidæ, some of which present a remarkable similarity to the true Insectivora.‡

In the West Indian Islands, however, which certainly belong to the Neotropical region, we meet with a single very anomalous and isolated form of Insectivores—the genus *Solenodon* of Brandt. Two species are now recognized of this extraordinary type, inhabiting different islands. The *Solenodon paradoxus*, made known to science by Professor Brandt, of St. Petersburg, as long ago as 1833, is from Hayti. The *Solenodon cubanus*, lately described by Dr. W. Peters in an elaborate Memoir in the Transactions of the Royal Academy of Sciences of Berlin, is, as its name indicates, from Cuba. The *Solenodon*, we may remark, had been previously noted as occurring in Cuba by Señor F. Poey, of Havana, who has done so much towards the investigation of the Fauna of that island, but had not been distinguished from its Haytian representative, until Dr. Peters came to compare the two animals together.

The great order of flesh-eaters, or Carnivora, which we now arrive at, is spread over the whole earth, with the exception of Australia, where, as has already been shown, its place is supplied by Marsupial forms modified to serve the same purpose. In South America, representatives of four of the families into which the Carnivora are usually divided are met with, namely, Felidæ, Canidæ, Mustelidæ, and Ursidæ. The Hyenas (Hyænidæ), which are usually recognized as a separate family, and the Civets (Viverridæ) are entirely restricted to the Old World, with the exception of the single Mexican genus *Bassaris*, which is commonly assigned to the latter family. We will commence our survey of the Neotropical Carnivora with the Digitigrade section, which embraces the three families Felidæ, Canidæ, and Mustelidæ.

Of the first of these families, all the South American representatives belong to the typical genus *Felis*. They may, however, be

* I call those genera "Arctopolitan" which are common to the northern regions of the two hemispheres, such as *Arctomys*, *Bison*, *Castor*, &c. Such forms as are common to the tropical regions (such as the Trogonidæ) may in like manner be called "Tropicopolitan."

† *Sorex micrurus*, Tomes, 'P. Z. S.,' 1861, p. 279.

‡ Especially the genus *Hyracodon*, Tomes, 'P. Z. S.,' 1863, p. 50.

divided into two sections: first, the striped and spotted Cats, headed by the Jaguar (*Felis onca*); and secondly, the uniformly-coloured species, of which the best-known example is the Puma (*Felis concolor*). The Jaguar is the largest and finest species of the Cat-group in the New World, and indeed yields only to the Tiger and Lion of the whole Feline family in strength and power. Besides the conspicuous differences of its markings, it is distinguishable from the Leopards of the Old World by its thick and compact form. The Jaguar has a wide range in America. In La Plata it is found in the eastern region, in the woods along the banks of the larger rivers. Throughout Brazil and Guiana it is also generally distributed, and according to Tschudi is met with in both the eastern and western Peru. It extends throughout Central America and Mexico, and into the United States as far north as the Red River of Louisiana.* In the grassy Llanos of Venezuela the Jaguar is said to be very abundant, the introduction of European cattle and horses having enabled these large beasts of prey to find subsistence in a region where, in its original state, they would have found much difficulty in obtaining a sufficient supply. The other South American Cats belonging to the "striped and spotted" section are mostly of comparatively small size. In the Pampas of La Plata the long-haired *Felis payeros* is the characteristic species, and extends all over the great plains which compose the eastern portion of this part of South America, going nearly as far south, according to Mr. Darwin, as the Straits of Magellan. In the coast-forests of South-eastern Brazil, *Felis mitis* and *F. macrura* occur; in the great Amazon valley, *F. tigrina*, *F. celidogaster*, and *F. pardalis* are met with. The latter species, under the form of one or more of several barely-distinguishable varieties, ranges all through Central America and Mexico into Texas. The uniformly-coloured Cats, which are further distinguished by the round pupil of the eye, are headed by the Puma, or "American Lion," as it is often called. The Puma has a still more extensive range in America than the Jaguar, or perhaps than any other species of Mammal. From Chili and Patagonia on the south, it appears to be distributed all over the southern and northern continents up to 50° or 60° N.L., thus presenting us with a range of some 110° of latitude. The Eyra (*Felis eyra*) and the Jaguarundi (*Felis yagouaroundi*), which belong likewise to the unspotted section, seem to accompany the Puma in its wanderings to a certain distance, being included by Burmeister among the Mammals of South-eastern Brazil, and by Baird amongst those of Texas. They are, therefore, doubtless also found in intermediate localities, although their exact range has not been yet well worked out.

So much for the Felidæ of South America. We must now say a few words about the Canidæ of the same country, which comprehend two well-marked types, *Icticyon* and *Canis*. Of these *Icticyon* em-

* Dr. Gray has described the Mexican Jaguar as distinct (*Leopardus hernandezi*, 'Proc. Zool. Soc.,' 1857, p. 278, pl. 58), but as a separate *species* I think it requires confirmation, being based merely on differences of coloration, which in the whole Feline group is very variable.

braces only a single peculiar species, first made known to science by Dr. Lund, in 1841. The *Icticyon venaticus*, or Cachorro di Mato of the Brazilians, has sometimes been referred to the Mustelidæ. But there is now no doubt, as Professor Burmeister (who formerly adopted this view) has himself shown,* that its proper place is with the Dogs (Canidæ), of which it is an aberrant form, resembling the Badgers (*Meles*) in habits, as in certain parts of its structure.

To Professor Burmeister we are also indebted for a very elaborate account of the American species of *Canis*.† These are seven in number, and are divisible into three sub-genera, which Professor Burmeister calls *Chrysocyon*, *Lycalopex*, and *Pseudolopex*. The first contains only the peculiar *Canis jubatus* of Desmarest, distinguished by its large size and brilliant colouring, which is found chiefly in the swampy and more open districts of Southern Brazil and the Argentine Republic. The second (*Lycalopex*) embraces three species: *C. cancrivorus*, of the wooded districts of Western South America, and *Canis vetulus* and *C. fulvicaudus*, of the Campos of Inner Brazil. The third (*Lycalopex*) contains three species; the best known of which is the *Canis azaræ*, which is very abundant all over the southern extremity of the American continent. Mr. Darwin tells us that this animal is "common in La Plata, Chili, and the whole of Patagonia, even to the shores of the Strait of Magellan." In the sterile and deserted regions of these countries this dog often prowls about by daytime, preying chiefly on the smaller Rodents. In Chili it is said to be very destructive in the vineyards from the quantities of grapes which it consumes, and necessitates the presence of watchers to keep it away. The *Canis magellanicus*, which is also a *Lycalopex*, seems to be confined to the western side of the Andean chain, ranging from "the humid and entangled forests of Tierra del Fuego to the almost absolutely desert country of Northern Chili." ‡

The Mustelidæ—a well-defined group of Carnivores, easily recognized by the presence of only a single tubercular molar in each jaw—are by no means abundant in South America, the greater number of the species being restricted to the more temperate regions of both hemispheres. There, nevertheless, occur within the limits of the Neotropical Region representatives of several genera belonging to this group to which we must call our readers' attention. Of the more typical Mustelidæ I am not aware that more than one species is certainly known as occurring in South America—the *Mustela frenata* of Lichtenstein, which may have probably extended itself southward from its original sedes in Mexico,§ along the Andean range.

In *Galictis*, on the other hand, we meet with a purely Neotropical form represented by two species, both belonging to Brazil and the

* Erlaüterungen z. Fauna Brasiliens, p. 1.

† Op. cit., p. 19 et seq.

‡ Darwin, in Zool. Voy. 'Beagle,' ii. p. 11.

§ *Mustela aureiventris* (Gray, 'P.Z.S.,' 1864, p. 55), from Ecuador, is probably the young of this species. *M. agilis* of Tschudi's Fauna Peruana is perhaps not different.

adjoining countries of South America, but not, as far as I know, found to the north of the Isthmus of Panama. *Mustela* and *Galictis* are the only two forms of Neotropical Mustelinæ. Of the Otters (*Lutrinæ*), which form a second well-marked division of the same family, distinguished by their aquatic habits no less than by their peculiar structure, several distinct species occur in South America. In Chili the *Lutra chilensis* is "exceedingly common among the numerous islands and bays which form the Chonos Archipelago." This otter by no means confines itself to fish, having been observed by Mr. Darwin to prey on volutes, cuttle-fish, and crabs. In Brazil the *Lutra brasiliensis* inhabits the river banks after the manner of our well-known European species.

The sub-family Melinæ, typified by our European Badger, includes the Skunks of the New World (*Mephitis*), so notorious for the suffocating odour which they produce when irritated, which have one or more representatives in South America, although the more typical species of the genus are found only in Middle and Northern America. The *Mephitis patagonica* is found over La Plata, Patagonia, and Chili; and other species have been described from various parts of Southern and Central America. The Southern forms all belong to the subgenus *Thiosmus* of Lichtenstein, but it seems doubtful whether they are anything more than varieties of one variable species.

The plantigrade Melinæ form the transition to the last family of Carnivora, the Ursidæ or Bears, which are essentially distinguished from the other groups of the same Order by their peculiar dentition. Of the typical genus, *Ursus*, only one species is generally acknowledged as South American—the Spectacled Bear (*Ursus ornatus*) of the higher Peruvian Andes. Tschudi has described a second (*Ursus frugilegus*), from the warmer zone of the same country, but I am not aware that specimens of this species exist in any European collection. Besides the Bears, however, three other genera belonging to the same family are found in South America—the Raccoons (*Procyon*), the Coatis (*Nasua*), and the Kinkajous (*Cercoleptes*). The South American Raccoon (*Procyon cancrivorus*) is a well-marked species, belonging to the same genus as the well-known Raccoon of the United States (*P. lotor*). It appears to be common in the forests of Brazil and Guiana. The Coatis (*Nasua*), distinguishable by their long tail and produced movable snout, have a wider range, from Mexico southward to La Plata. Many species have been described of this genus, but it still remains doubtful whether there exists more than one variable species. The Kinkajou (*Cercoleptes*) is still farther aberrant from the typical Bears than either of the two last-named genera, and is sometimes considered as the type of a distinct family. It may be regarded as a characteristic form of Neotropical Mammals, being restricted to the wood regions of the Amazon valley and countries northwards as far as Guatemala. Only one species of this peculiar, prehensile-tailed, nocturnal Mammal-form is known to science.

The subjoined table will show at a glance the principal forms of Neotropical Carnivora, the names of those restricted to the Neotropical

Region, and therefore especially characteristic of this Fauna, being printed in italics :—

CANIDÆ.	FELIDÆ.	MUSTELIDÆ.	URSIDÆ.
Icticyon Canis	Felis	Mustela *Galictis.* Lutra Mephitis	Ursus Procyon *Nasua* *Cercoleptes*

The Rodentia, which now claim our attention, in South America, as in nearly every other part of the world, are more numerous in species, and more abundant in individuals, than any other order of Mammals. A considerable number of genera belonging to this group are also peculiar to the Neotropical Region, especially, as we shall see, among the Hystricine forms, which are very extensively developed in this part of the world. In attempting to give an outline of the more noticeable features of this difficult group, I shall base my remarks principally upon Mr. Waterhouse's paper on the distribution of this Order, given in the Zoological Society's 'Proceedings' for 1839, and in the same author's volume on the Leporidæ and Hystricidæ in his excellent (but, alas! unfinished) 'History of Mammals.' In the above-named paper of Mr. Waterhouse, the Rodentia are divided into eight families. In the tables subsequently given in Keith Johnston's 'Physical Atlas' only four of these are adopted, namely—Sciuridæ, Muridæ, Hystricidæ, and Leporidæ. To these I agree with Professor Baird in adding, as a distinct family, the Saccomyidæ or Pouched Rats, distinguished by their large and distinct external cheek-pouches, a group peculiar to, and very characteristic of, the Northern Region of the New World, which may be intercalated between the Muridæ and Sciuridæ.

The Sciuridæ, which must be placed at the head of the Rodentia, are by no means abundant in South America. Of five well-marked genera—*Sciurus*, *Pteromys*, *Tamias*, *Spermophilus*, and *Arctomys*, commonly referred to this family, but one—typical *Sciurus*—occurs at all within the limits of the Neotropical Region. And of *Sciurus*, out of some sixty or seventy known species, seven or eight only are South American. In S.E. Brazil the only species mentioned by Burmeister are *Sciurus langsdorfii* of the interior and *S. æstuans*, which is common all along the forests of the eastern coast. The latter Squirrel is alone attributed to Guiana by Schomburgk. In Eastern Peru, besides this two others occur, according to Tschudi, and a fourth (*Sciurus stramineus*) has been obtained from the western coast-region of the same country. In the Amazon Valley several others are met with, specimens of which were first obtained by the indefatigable collector Johann Natterer. No squirrel is given by Rengger or Azara as occurring in Paraguay, so that we may take the southern limits of this form as terminating with the forest region of Brazil. In Central America, on the other hand, as we go north, the species become more numerous, four *Sciuri* having been obtained in Guatemala by Mr. Salvin, and several others occurring in Southern Mexico.

The Muridæ are, on the contrary, very numerous in South America, as in most other countries, but belong to a different section of the family from the typical *Mures* of the Old World. They have been constituted a particular tribe or sub-family by Burmeister, under the name *Sigmodontes*, from the peculiar structure of the molar teeth, by which they are readily distinguishable from their representatives in the Eastern hemisphere. The best-marked South American genera included in this section are *Hesperomys*, *Rithrodon*, and *Holochilomys*. *Hesperomys* and its subdivisions embrace some forty species, generally diffused over South America. *Rithrodon* embraces three species, all from La Plata and the southern extremity of the continent. *Holochilomys* has four Brazilian species. Other less known genera of this group are *Acodon* and *Drymomys*, founded on single species from Peru. I should mention that the common European species of true *Mus* are likewise firmly established in many parts of South America, but doubtless owe their introduction to the agency of man.

We now come to the Hystricidæ, which, as I have already said, is essentially a South American group. Mr. Waterhouse divides this family into six minor sections or sub-families, *viz.* Hystricina, Dasyproctina, Echimyina, Octodontina, Chincillina, and Cavina. Of these the true porcupines (*Hystricina*) are alone widely distributed, the two typical genera of this group, *Hystrix* and *Atherura*, being found in the Old World. The five remaining sub-families, if we except the two African types *Aulacodus* and *Petromys*, are entirely restricted to the Neotropical Region. We must devote a few remarks to each of these groups.

The Cavies (*Cavina*) embrace three well-marked forms, all restricted to South America—*Dolichotis*, *Cavia*, and *Hydrochœrus*. *Dolichotis* contains only the hare-like Patagonian Cavy (*D. Patachonica*), which forms one of the characteristic features of the Patagonian landscape, being common all over the gravelly deserts of that country. *Cavia* is known by some seven or eight representatives, mostly Brazilian, but in one instance extending far southwards down to the Magellan Straits. Our domestic "Guinea pig" is derived from one of these species, a native of the banks of the Rio de la Plata. The Capybara (*Hydrochœrus*), the largest known species of Rodent, is also abundant in the vicinity of the same river, though it extends far northward over all Brazil into Peru and Guiana. It is generally stated to be the favourite prey of the jaguar. The Chincillas, which from the second sub-family of Mr. Waterhouse's arrangement, are chiefly found in the mountainous districts of Peru and Chili, though one species (the Viscacha) is confined to the plains of La Plata, and forms a very prominent feature in the Zoology of the Pampas. The Alpine Chinchillas (*Lagidium* and *Chinchilla*), so remarkable for their soft and delicate fur, which caused them to be known commercially long before we became acquainted with their curious structure, are distributed over the Andes of Chili, Bolivia, and Peru, and range up to an altitude of 12,000 feet above the sea-level. The third sub-family (Octodontina) is again exclusively South American, embracing about a dozen species referable to the genera

Habrocoma, *Octodon*, *Schizodon*, *Spalacomys*, and *Ctenomys*, which inhabit the middle and southern parts of that continent, occurring on both sides of the Andean range. They are all of small size, and are partly of burrowing, partly of more or less climbing, habits, agreeing with the Cavies and Chinchillas in having rootless molars, but readily distinguishable from these two families by the possession of five well-developed toes on the hind feet. The *Spalacomys poeppigii* presents a curious deviation in mode of life from the rest of the group in living nearly entirely under ground, and only occasionally emerging at night-fall. In the next sub-family (the Echimyina) we meet with two African types, *Petromys* and *Aulacodus*. The remaining genera, *Capromys*, *Myopotamus*, *Cercomys*, *Dactylomys*, *Loncheres*, and *Echimys*, are all exclusively Neotropical types. *Capromys* and *Plagiodus* are characteristic forms of the Antilles. The other genera inhabit the northern and central portions of the continent, not, however, as far as I know, occurring northwards of the Isthmus of Panama. The best known animal of this section is, perhaps, the water-loving Coypu (*Myopotamus coypus*), which has much superficial resemblance to the Beaver (*Castor*), and has been erroneously associated with that animal. The Agoutis (Dasyproctina) form the fifth subdivision of the great Hystricine family according to Mr. Waterhouse's system. They embrace two genera, *Cœlogenys* and *Dasyprocta*, both exclusively Neotropical. The first-named genus contains but one well-established species, the Paca, *Cœlogenys paca*. Nothing can give a better idea of the poverty of large animals useful for food in the Amazonian forests, than the fact that this little animal and the Coypu are the species most sought after for food by the hungry hunter, who, in a corresponding latitude in Africa would be feeding on the flesh of elands and giraffes. The Agoutis (*Dasyprocta*) are nine or ten in number, extending from Paraguay and Bolivia into Mexico.* This is also one of the few genera of Mammals (exclusive of Bats) which occur in the West Indian Islands. Lastly, we come to the sixth sub-family, Hystricina, of which the most typical forms, *Hystrix* and *Atherura*, are peculiar to the Old World. The American Porcupines form, in fact, quite a separate section of the group to which Professor Brandt has given the name "Philodendreæ," from their tree-loving habits. They are divisible into three genera, *Erethizon*, *Cercolabes*, and *Chætomys*. The first of these is a Nearctic† form, the remaining two are Neotropical. *Chætomys* contains but a single Brazilian species; *Cercolabes* comprehends a series of a dozen species or so, which are diffused all over the forests of America from Mexico to Paraguay.

The last family of Rodents, the Hares (Leporidæ), contain only two generic forms, *Lepus* and *Lagomys*. The latter is an Arctopolitan type, being confined to the Palæarctic and Nearctic regions. *Lepus* is thinly diffused over the greater part of the world, except the Australian

* M. de Saussure has lately described a Mexican species, *D. Mexicana*. 'Rev. Zool.,' 1860, p. 53.

† Dr. Gray has recently described a species of *Erethizon* from New Granada (*E. rufescens*, 'P. Z. S.,' 1865, p. 321), but I doubt its truly belonging to this genus; and Dr. Gray has provided a sub-genus for its reception (*Echinoprocta*).

region, but appears especially prevalent in North America, where some twelve or thirteen species are known to occur. In South America a single species of Hare only is found—the *Lepus brasiliensis*, which extends over Brazil and the adjoining parts of Peru, Bolivia, and Paraguay. With this species is concluded the long series of Neotropical Rodents.

The next succeeding orders of Mammals contain all the largest and most bulky animals at present existing on the earth's surface. In considering them we shall at once see the poverty of the Neotropical region in these forms of animal life as compared with the corresponding parts of the Old World. While Asia and Africa have each their species of Elephant, no Proboscidean is known to the existing Fauna of the New World. While four types of Perissodactyles are found in various parts of the Eastern Hemisphere, the Western World numbers only one of these forms in its existing Fauna. Among the Artiodactyles of the Neotropical regions we look in vain for anything corresponding to the *Hippopotami* and Wart-hogs of Africa. The non-ruminant division of this Order is only represented in America by two species of the peculiar genus *Dicotyles*. When we come to the Ruminating Artiodactyles, the contrast is still greater. Where in South America can we find anything to compare to the 70 or 80 species of Antelopes and other Bovidæ of the Indian and African Faunas? This great family, the most useful of all to mankind, is absolutely without a single representative in the whole of the Neotropical region. Throughout the greater part of the immense area of South and Middle America the only Ruminants to be met with are some scattered species of Deer (*Cervus*)—the second and only peculiar Neotropical form of the Ruminants being confined to the elevated regions of the Bolivian and Peruvian Andes. The following table shows the general distribution of the Ungulata:—

Distribution of the Ungulata.

1. Neotropical Region.	2. Nearctic Region.	3. Palæarctic Region.	4. Æthiopian Region.	5. Lemurian Region.	6. Indian Region.	7. Australian Region.
		Equidæ	Equidæ		Equidæ	
Tapiridæ					Tapiridæ	
			Hyracidæ			
			Rhinocerotidæ		Rhinocerotidæ	
			Hippopotamidæ			
Suidæ			Suidæ		Suidæ	
			Tragulidæ		Tragulidæ	
		Moschidæ				
Cervidæ	Cervidæ	Cervidæ			Cervidæ	
			Camelopardalidæ			
Camelidæ		Camelidæ			Camelidæ	
	Bovidæ	Bovidæ	Bovidæ		Bovidæ	

I must add a few words on the special distribution of each of the four Neotropical representatives of the Ungulata.

The Tapiridæ of South America are two in number: the common and well-known *Tapirus americanus*, which is found all over the wood

regions of Central and Southern America, and the Hairy Tapir (*T. villosus*), a little-known species peculiar to the Peruvian Andes, of which, I believe, there is no specimen in any museum in this country.

Of Suidæ, as I have already said, the Neotropical region possesses but a single form, the Peccary (*Dicotyles*). The two known species of this form appear to be widely diffused from Guatemala throughout Central and Southern America to Paraguay, wherever suitable localities exist. The Collared Peccary (*D. torquatus*) ranges farther northward than the white-lipped species, occurring even in the plains of Texas.

The Cervidæ of the Neotropical region are some nine or ten in number, pretty generally distributed throughout the whole area, except in the extreme South. They are all, however, referable to the less typical forms of the group—true *Cervus* only occurring in the Palæarctic and Nearctic Regions. *Furcifer*, *Blastocerus*, and *Coassus* are the sub-generic names of the Neotropical forms of this family.

Lastly, the Camelidæ of the Old World are represented in the Bolivian and Peruvian Andes by the genus *Auchenia*, of which there are usually held to be two distinct wild species, the Guanaco (*A. guanaco*) and the Vicugna (*A. vicunia*), the Lama and Alpaca being generally considered to be domestic varieties derived from their stocks respectively.

The next following Order of Mammals—the Edentata of Cuvier—forms one of the most characteristic features of Neotropical Zoology. Of the two great divisions which make up the Order, one—the Phyllophagous section, comprehending the single family of Sloths (Bradypodidæ)—is wholly peculiar to this region. Of the second or Entomophagous division, two families, which contain the greater number of the species, are likewise restricted to South America—leaving only two types (*Orycteropus* and *Manis*) represented throughout the whole of the Eastern Hemisphere.

The subjoined table will show at a glance the general distribution of the whole Order Edentata over the earth's surface:—

1. Neotropical Region.	2. Nearctic Region.	3. Palæarctic Region.	4. Æthiopian Region.	5. Lemurian Region.	6. Indian Region.	7. Australian Region.
Bradypodidæ Dasypodidæ Myrmecophagidæ			Manididæ Oryctoropodidæ		Manididæ	

The leaf-eating Sloths forming the family Bradypodidæ are quite as extraordinary in their habits as in their organization, and certainly constitute one of the most *outré* groups in the whole class of Mammals. Being so exclusively arboreal as, in a state of nature, never, perhaps, to touch the ground during the whole period of their existence, the Sloths are necessarily confined to the densely-wooded districts of Southern and Central America, and in conjunction with other arboreal

types, seem to indicate that these vast forests must have existed in a state not very different from their present condition during a vast period. The most northern locality hitherto recorded for any member of this group is Costa Rica, whence Dr. Peters has lately received several examples of a new and very interesting species of the two-toed genus *Cholœpus*.* Thence they extend southwards over the great wood region of Brazil and Peru to the frontiers of Paraguay and La Plata. About six species of *Bradypus* and two of the genus *Cholœpus* have been recognized by naturalists, but several of the former require further elucidation.

The Entomophagous Edentates of America consist of two very distinct families, the Armadillos (Dasypodidæ) and the Anteaters (Myrmecophagidæ). The former is rather a numerous group, some twenty species being known to science. A single Armadillo (*Dasypus peba* var. *mexicana*, Peters) occurs as far north as Texas. Hence descending southwards, the form is diffused all over the Continent down to Patagonia. In the Argentine Republic Dr. Burmeister records the presence of five species. The more typical section of this family (Dasypodinæ) is divisible into several genera. A second sub-family (Chlamydophorinæ) contains only the very remarkable form *Chlamydophorus*, of which the species originally described, and long considered as the only existing representative of this most extraordinary form, is exclusively confined to the vicinity of Mendoza in the Argentine Republic. A second species recently described by Dr. Burmeister (*C. retusus*) is from the province of Sta Cruz de la Sierra, in Bolivia. The Anteaters (Myrmecophagidæ), very distinguishable from the Armadillos by their extensile tongue, wholly toothless jaws, and hairy covering, are not so numerous in species. Of the largest and only terrestrial form *Myrmecophaga*, one species only is known to exist. Of each of the two arboreal genera with prehensile tails (*Tamandua* and *Cyclothurus*) two species have been described. Both these forms extend to the north of the Panamanic Isthmus, the former into Southern Mexico,† and the latter as far as Costa Rica, whence a second species has recently been described by Dr. Gray.‡

A few words more only remain to be said about the lowest form of the Mammal-type in South America, the Marsupials, which the New World possesses in common with Australia. But whereas in Australia Marsupialism is the prevalent form of Mammalian life, and exhibits itself in several very distinct families, only one group of Marsupials exists in the New World to which it is likewise peculiar. This is the family of Opossums (Didelphyidæ), containing three principal genera (*Didelphys*, *Chironectes*, and *Hyracodon*). The first of these contains a series of species of arboreal habits, varying in size from the bulk of a common cat, such as the Virginian Opossum (*D. virginiana*), to that of a common house-mouse, such as *D. tristriata*. They are diffused all over Southern and Central America, from the

* *Ch. hoffmanni*, Peters.

† Cf. de Saussure, 'Rev. Zool.,' 1860.

‡ *C. dorsalis*, Gray, 'Proc. Zool. Soc.,' 1865, p. 385, pl. xviii.

TYPICAL MAMMALS OF SOUTH AMERICA

Rio de la Plata to the United States, but seem to be most numerous in Brazil, whence some twenty species have been obtained. *Chironectes*, the second genus of American Marsupials, contains only one known species, the *Chironectes variegatus*, or Water-Opossum of Brazil and Guiana, distinguished by its aquatic habits, as well as by modifications of structure which adapt it to that mode of life. *Hyracodon*, the third and last, likewise contains only a single type remarkable for its Insectivorine dentition, which has been recently made known to science by Mr. Tomes.*

Having now done my best to give a general outline of the principal forms of Mammals found within the Neotropical area, it only remains to recapitulate the principal characteristics which distinguish this region from the other great regions of the world's surface. These, I think, may be stated as follows:—

1. The possession of two families of Quadrumana (Cebidæ and Hapalidæ), constituting a special section of this Order (Platyrhina) peculiar to this region.

2. The absence of the true frugivorous Bats (Pteropodidæ) and the presence of a peculiar family of Chiroptera (Phyllostomatidæ), some forms of which are frugivorous, and others feed solely on the blood of living animals.

3. The absence of Insectivora, except the singular genus *Solenodon* of the Antilles.

4. The absence of Viverridæ, and the presence of several peculiar genera of Carnivores (*Icticyon*, *Galictis*, *Nasua*, and *Cercoleptes*).

5. The absence of true *Mus*, which is replaced by *Hesperomys* and allied forms, and the presence of numerous forms of Hystricidæ, constituting nearly the whole of this extensive and varied family.

6. The absence of Proboscideans and Perissodactyles, except Tapirus.

7. The great poverty of Ruminants, the family Bovidæ being entirely unrepresented, and only *Cervus* and *Auchenia* occurring out of the whole Sub-order.

8. The presence of three families, containing by far the majority of genera and species, of Edentates.

9. The possession of a peculiar family of Marsupials, which has intruded itself into the Nearctic Region, but is unknown elsewhere.

DESCRIPTION OF THE ILLUSTRATION.

Mr. Wolf's plate represents a (rather crowded) scene in a Brazilian forest. Hanging from the branches in the left-hand corner is a two-toed Sloth (*Cholœpus didactylus*). Below it is a Kinkajou (*Cercoleptes caudivolvulus*). In the upper right-hand corner are various American Monkeys (*Cebus*, *Callithrix*, *Pithecia*), with a large Spider Monkey (*Ateles*) hanging by its tail in front. On the ground is a pair of Armadillos (*Tolypeutes tricinctus*), to the right a great Anteater (*Myrmecophaga jubata*), and, with its prehensile tail coiled round a tree, to the left a Tamandua Anteater (*Tamandua tridactyla*). A pair of Tapirs (*Tapirus americanus*) are enjoying a bath in company with a Capybara (*Hydrochœrus capybara*), while a Jaguar (*Felis onca*) is drinking in the background.

* 'Proc. Zool. Soc.,' 1863, p. 50.

STRATA IDENTIFIED BY ORGANIC REMAINS.

By H. M. Jenkins, F.G.S , Assistant-Secretary of the Geological Society.

'Strata Identified by Organized Fossils' was the title of a well-known work by William Smith,* in which he illustrated his discovery that the numerous formations constituting the crust of the earth could be distinguished and identified by means of their imbedded fossils. The term "organized fossils" was used by this celebrated author because all kinds of imbedded minerals and stones, whether of organic origin or not, had previously been called "fossils;" but, as the latter epithet became restricted in its meaning, so as to be synonymous with the former, the term "organized fossils" became obsolete, and "fossils" were spoken of simply as such, or as "organic remains;" thus we arrive at the origin of the title of this article,—"Strata Identified by Organic Remains." In these pages I shall endeavour to examine the present state of geological opinion respecting this great generalization of the "Father of English Geology," as William Smith has been appropriately styled, for his discoveries, especially the one which now most concerns us, have undoubtedly been the foundation of all modern Geology.

This discovery gave a new direction to geological inquiry. Before its promulgation geologists had been contented to describe strata as so many rocks and minerals, having certain peculiarities of dip, strike, colour, hardness, and so on; and the imbedded fossils were merely considered to be extremely curious and more or less adventitious; in fact, they were at one time called "extraneous fossils," a term which has since obtained a widely different and very much restricted meaning. Afterwards, however, they necessarily became invested with a higher interest, for they were shown to be not only curious, but also extremely useful and important. Zoology and Botany received a great impetus, both on account of the light they threw on the nature of fossils, and because of the number of new and curious organisms discovered in the fossil state, which helped to explain aberrant recent forms. It was now, also, no longer necessary to trace a continuation between the rocks of two or more localities to be assured of their identity; if they contained the same fossils, they were as absolutely "identified" as if their physical continuation were exposed along their whole line of strike. Henceforth the labour of tracing the distribution of strata was very much reduced, as also were the chances of error; consequently the characters of fossils received a vast amount of attention, and their study rapidly became a science of itself, and this new science—Palæontology—has completely changed the aspect of its parent, and in many instances has altered its language.

Palæontologists were soon enabled to show that the older the stratum whence organic remains were derived, the less resemblance did the fossils bear to recent organisms, and the more dissimilar to the

* Published in 1817.

recent did the fossil faunæ become. This induction was quickly followed by an attempt at classifying the rocks into great systems and subordinate formations and beds; but into the details of these efforts I need not enter. Naturally the next step was to compare the formations of different countries, to ascertain the coincidences, and to find out the gaps. And thus we come to the line of research that first suggested a modification of the accepted doctrine,—"Strata Identified by Organic Remains."

Englishmen have generally been foremost in every field, from breaking stones as geologists to scaling the Matterhorn; and, as Sir Roderick Murchison has just remarked, in his Presidential Address to the Geological Section of the British Association, the great divisions of Silurian, Devonian, and Carboniferous, first established in England, have been adopted on the Continent. The attempt to correlate the formations of different countries was pursued with great zeal and good results, and at first without endangering the universal application of William Smith's great law; but as Palæontology advanced, her votaries became more critical, and infinitely better naturalists, and they found that, as the distance between similar formations increased, the proportion of identical species became smaller. The explanation generally given and readily received was, that this difference in organic contents was due to difference of latitude and to local modifying causes, and thus "Strata Identified by Organic Remains" continued to be accepted both as a motto and a law, a foundation of faith on which the whole structure of modern Geology was built, and the truth of which was unassailable.

Such being the state of Geological opinion, what was the astonishment of the Fellows of the Geological Society when, at one of their meetings in March, 1846, Professor Edward Forbes declared "that identity of fossils in strata geographically far apart must lead to the inference that the beds were of *different*, not, as hitherto maintained, of the same age."* But although Geologists were astonished, and perhaps, as Edward Forbes expressed it, "terrified," their astonishment or terror took no practical shape. The promulgator of this new doctrine, like most men of genius, was in the habit of giving vent to apparently strange ideas, some of which were the result of careful observation, combined with great extraneous knowledge and a powerful imagination, while others were due to the imagination alone, and required time for their merit to be acknowledged. Accordingly his heresy did not produce any permanent effect at the time, notwithstanding the "terror" it excited, and it was not until sixteen years afterwards that the subject was revived in a manner sufficiently authoritative to challenge public attention. Then, in 1862, Professor Huxley took the opportunity afforded by an Anniversary Address to the Geological Society to bring this heterodox doctrine again before the notice of that learned body, and since then several of the younger palæontologists have given the idea its due weight in endeavouring to correlate distant deposits.

* *Vide* Wilson and Geikie's 'Memoir of Edward Forbes,' p. 395

Having given a brief outline of the history of our subject, I must endeavour to explain the reasons that induced Professor Edward Forbes to give utterance to the sentence I have just quoted, and that instigated his successors to revive his opinion. Let us suppose that during the deposition of the most ancient fossiliferous rocks, the world was peopled by a single assemblage of animals and plants; in other words, that the same aquatic species existed in every part of the ocean under the same conditions, and the same land-species on the whole surface of the dry land, also under the same conditions. In this case it is obvious that the strata of that period could now, all over the world, be absolutely identified by their organic remains. But if we take a survey of the fauna and flora of the globe as they now are, we shall find that the very reverse of our supposition is what occurs at the present time; for the surface of the earth consists of a number of zoological and botanical provinces, each one of which has an assemblage of animals or plants more or less peculiar to it. It is therefore very unlikely that a geologist of some Post-Quaternary period will be able, with our means and appliances, to identify and correlate by their organic remains distant deposits of our period; such, for instance, as are being formed in the Baltic and on the shores of the Indian Ocean.

But this is by no means the whole of the case for the opponents of the old view. The views of all geologists on this question must depend more or less on their belief in the origin of species by descent with modification, and from single "specific centres." Taking first the affirmative view of these theories, it must be allowed that it takes a considerable time for a species to extend itself over a large area from the spot where the modified descendant could first be called a new species; but it takes a still longer time, after the full geographical extension of the species has been reached, for that species to emigrate to a distance in consequence of a change in the conditions of existence, such as alteration of climate, in the depth of the sea, in the abundance and quality of food, &c. In illustration of this point I may cite several facts, especially the occurrence of the Reindeer in the South of France during a late, but still pre-historic period, and its existence at the present day in Arctic regions. Again, *Cyrena fluminalis* (Plate, fig. 1) occurs abundantly in the brick-earths and gravels of the Thames Valley, and exists now in the rivers of more southern latitudes, ranging from Egypt to China; and a parallel instance is afforded by *Argonauta hians* (Plate, fig. 2), which occurs fossil in Pliocene European deposits, and ranges now as far as the coasts of China. A stronger case is, perhaps, afforded by the fact that a large number of species which occur fossil in the Miocene deposits of Europe (for instance, Plate, fig. 3) live now in tropical latitudes, chiefly on the shores of the Indian Ocean, so that the fossils of the strata now being deposited in that region cannot be very different in facies from those of the Miocene formation of Europe.

One apparent objection to this doctrine becomes a corroboration, when subjected to a searching examination, as is not unfrequently the case with unsound objections to true theories. Opponents to the

theory of descent with modification, who are also advocates of the orthodox maxim of "Strata identified by organic remains," will say—"But if these species came into being first, for instance, in the Miocene seas of Europe, and emigrated thence south-eastwards as the climate of Europe changed, they should, according to your views, have undergone some alteration by the way;—in other words, they should by this time have been 'modified' into new species." The corollary that would be drawn from this is that the 'descent with modification' doctrine is incompatible with the other.

In reality, however, it is only the strongest and most stable of the Miocene species that did withstand the wear and tear of their long voyage; the great majority of them were "modified" into the "representative species," as Professor Forbes called them, which now exist in sub-tropical regions, their Miocene ancestors being extinct. The more hardy species which did contrive to exist unchanged (such as the one represented in Plate, fig. 3) remain as witnesses to prove the emigration, while the more changeable forms, by having become altered so much as to be considered new and representative species, bear testimony to the effect that is so often wrought upon species by a change in the "conditions of existence," and also to the probable truth of the theory of descent with modification.

A very interesting example of a variation which *may* be due to a process of modification has occurred to me during the examination of Miocene Mollusca from different parts of the world. In 1863, I described and figured a Tertiary shell from Java (Plate, fig. 8), which appeared to be the young of the recent *Oliva utriculus;* but although I had a large number of specimens, not one of them seemed to have reached the adult state. In other respects there was scarcely the most fractional difference to be detected between the fossil and the young of the recent species, but the former differed very markedly, of course, from full-grown specimens of the latter (Plate, fig. 9). Since then I have met with another series of specimens of the same species from the Miocene strata of Crete, exactly corresponding with those from Java, and all presenting the characters of the young of *Oliva utriculus*, but unassociated with any specimens comparable to the adult state of that species. Now it appears probable, that during the Miocene and later Tertiary periods this shell never got beyond the young state of the existing species; and that its present excessive growth and development, owing probably to very favourable conditions, may be but a portion of a course of modification that will ultimately produce a sufficient divergence in the two forms to entitle them to rank as distinct species. In fact, if we were not so well acquainted with all the stages of growth of the recent form, they would be considered so now.

Having used the term "representative species," it is necessary to define it. Those species, then, are "representative" which appear to hold a place in one zoological province, or geological formation, corresponding to that held by the species they represent in an equivalent province or formation. Sometimes the representative species are clearly very closely allied to those they represent; but it frequently

happens that they are only analogous species. In illustration of this latter point I may mention that in the Tertiary strata of Victoria and South Australia are found a number of species of *Voluta* with blunt spires,* but otherwise scarcely distinguishable from the Eocene sharp-spired species of *Voluta* occurring in Britain (compare Figs. 4 and 5 of the annexed Plate). But does it therefore follow that these two sets of strata, so widely distant from one another, are of the same age? By no means, as it seems to me. For, leaving the distance out of the question, for fear of being charged with the fallacy of "begging the question," all the *actual* evidence (as distinguished from the *ideal*) goes to prove that the Australian beds are much the more recent. In these beds the curious species of *Trigonia*, which formed the subject of a note by me in the April number of this Journal, has been found. It is represented in Fig. 6 of the Plate, and the type of the group to which it belongs (*T. costata*, an Oolitic species) in Fig. 7.

Zoologically, therefore, if two series of strata can be correlated only by means of representative species, their actual ages ought to differ more widely than those which have some species in common. And observed facts really give strength to this inference, for it rarely happens but that the less distant strata, presumably contemporaneous, have more species in common than those which are more widely separated. This argument may, of course, be pushed still farther, as when the species cease to be evidently representatives, or when they belong to different genera; but it must always be borne in mind, that it has no force whatever unless strong collateral evidence exists, such as would ordinarily induce a geologist or a palæontologist to correlate the one formation with the other. There are no strong lines in nature, and when the affinity of the fossils of two formations becomes very weak, it ordinarily happens that we must look above or below the one selected as a standard for comparison, in order to find the deposit which seems, *primâ facie*, to be the nearest in age to the one we wish to correlate.

The fearful palæontologist may ask what limits are to be placed upon the apparent difference in age of two formations apparently contemporaneous. In mathematical language, what is the *function* with which we are to differentiate the ages of apparently contemporaneous strata? It appears to me that we have that function in the term Geographical Space; for I believe that as the distance between the formations becomes greater, so does, *cæteris paribus*, the difference in age increase. In other words, Geographical Space and Geological Time have the same sort of correlation as Electricity and Magnetism; with apparently contemporaneous strata a certain distance means a certain lapse of time, and as one varies so does the other. Still, this is an individual opinion, and it does not quite coincide with that expressed by other writers. Professor Huxley, for example, states that, "For anything that geology and palæontology are able to show to the contrary, a Devonian fauna and flora in the British Islands may have

* See Prof. M'Coy's Contribution to the 'Victorian Essays,' p. 168.

been contemporaneous with Silurian life in North America, and with a Carboniferous fauna and flora in Africa. Geographical provinces and zones may have been as distinctly marked in the Palæozoic epoch as at present, and those seemingly sudden appearances of new genera and species, which we ascribe to new creation, may be simple results of migration."* This seems to be pushing the conclusion rather beyond the limits of logical inference, unless geological time is something very different from what the students of Hutton and Lyell have been taught to believe.

Mr. Seeley, however, with greater enthusiasm and less caution than Professor Huxley, makes the apparently extraordinary statement that "Palæozoic, Mesozoic, and Tertiary, are convenient fictions."† But it is not unlikely that, though he appears to say more, this palæontologist actually means the same as myself, namely, that there is no *absolute* division all over the globe between rocks of Palæozoic, Mesozoic, and Tertiary ages; for it is conceivable to me that the Maestricht Chalk may have been deposited contemporaneously with apparently Eocene beds in another region, and with apparently Lower Chalk strata in a third.

The same author begins another memoir ‡ by the, to some, equally startling heresy that "The evidence of a rock's age derived from fossils can never be quite conclusive, and never rank as equal in value with sectional evidence;" but I imagine that in this instance he must refer to cases where a lithological continuity can be traced, and not to widely separated and totally unconnected sections. It is conceivable that sectional evidence may sometimes be superior to palæontological; but I should very much doubt whether it is possible that this should always be the case. I can understand why the presence of certain minerals, which have always before been found to characterize particular deposits, or the existence of certain structural peculiarities, such as have hitherto occurred only in rocks of one period, should determine the age of a stratum at a great distance from its supposed analogues much better than weak or scanty fossil evidence; but it happens more frequently than otherwise that the palæontological evidence is very much stronger than either the stratigraphical or petrographical, in regard to the question of correlation with unconnected or distant deposits.

A fertile source of error in the determination of the synchronism of geological formations lies in the very different depths of the sea-bottoms on which strata of the same period may have been deposited. This refers equally to mineral composition and fossil contents, for while the sediment deposited varies, generally speaking, from the pebbles of the sea-shore, through sand to clay, and thence to the coral-reefs and calcareous deposits of the ocean, so the inhabitants of these different zones exhibit a gradual change, not only in species but also

* "Address Geol. Soc.," 1862, p. 22. 'Quart. Journ. Geol. Soc.,' vol. xxviii. p. xlvi.

† "On the Significance of the Sequence of Rocks and Fossils." 'Geol. Mag.,' vol. ii. p. 264.

‡ "On the Fossils of the Hunstanton Red Rock." 'Annals and Mag. Nat. Hist.,' 3rd ser., vol. xiv., 1864, p. 276.

to a large extent in genera; consequently it would be extremely difficult to correlate the littoral accumulations of one region with the deep-sea deposits of another. This is only one of the many sources of complication that render the problem of the relative age of distant deposits so very difficult of solution, and that conspire to place CAUTION at the head of the cardinal virtues in the code of morality recognized by palæontologists.

Philosophical geologists, who cannot but admit the weight of the arguments that have been put forth in favour of the doubtfulness of the relative age of strata apparently contemporaneous, but who are still unwilling to admit such an element of uncertainty into their reasonings, for fear that it would prove a kind of inductive guillotine always ready to fall and cut off their otherwise legitimate inferences, take refuge in an assertion that may be stated in the words of Professor Ramsay, one of the most eminent and philosophical of the geologists who cling to the old notion; he says, "It appears to me, however, that such reasoning is in error, simply because the reasoner is apt, unintentionally, to consider a whole formation, perhaps from 1,000 to 7,000 feet thick (as in the case of the Bala beds and Hudson River group), as if it were *a bed or a thin set of beds representing a particular sea-bottom at a particular time*, whereas the Bala beds represent a great many thousands of sea-bottoms more or less regularly piled on each other very slowly. The question must therefore arise, in connection with duration of species, whether under any circumstances the possible time, for instance, that it might have taken to transmit species from the English to the American area is likely to be comparable to the amount of time represented by the interval between the lowest and the highest Bala strata, *or even of a longer period*."* The gist of which statement is, that the lapse of geological time, which takes place during the deposition of a formation like the Bala beds, is something so overwhelmingly great in comparison with that required for the emigration of a fauna to a great distance, that the occurrence of the emigration during the deposition of such a formation would have no appreciable effect on the true, in relation to the apparent, relative ages of even a minor subdivision of them. But I have already hinted in this article (p. 624) that the recent East Indian Mollusca are so clearly related to European Miocene species that deposits now being accumulated near the shores of the Indian Ocean might easily in future be mistaken for Miocene, and Dr. Duncan has conclusively shown that European Miocene Corals are distinctly East Indian in their affinities. Now the Miocene formation may be roughly considered to be nearly of an equivalent thickness to that of the Bala beds, and many of these East Indian shells occur in its lowest subdivisions. But of more recent date we have the whole of the Pliocene and younger deposits, which attain, probably, in places, an aggregate thickness of 4,000 or 5,000 feet more. And yet, notwithstanding this great mass of material that has been deposited since the Miocene fauna first appeared in Europe,

* Address Geol. Soc., 1863, p. 25.

it appears to me that there is not sufficient difference between it and the existing East Indian fauna to warrant any future "Post-quaternary" geologist with our present principles, taking into account the difference of latitude, and not giving any weight to the doctrine I am advocating, in assigning it to any other than a Miocene period. Therefore I believe that the time required for the deposition of a formation several thousand feet in thickness, is not necessarily greater than that required for the emigration of a fauna to a great distance, when caused by a change of climate or a considerable alteration in the physical features of the earth's surface.

Professor Ramsay makes another objection that requires a few words of explanation, as he considers it of importance. He remarks that, "if the idea put by Professor Huxley be just, it appears to me that in the piles of formations built up in Britain, on the Continent, and in America, the chances are overwhelmingly strong, that in each or in some one area there might be a *recurrent fauna*, which is not the case. To this I attach great weight." * There are two answers to be given to this objection: first, when the physical changes have not been sufficiently great to expel the fauna completely, then we do get an actual recurrence, of part of a fauna, at least; secondly, that when the physical changes have been very great, they must have occupied so long a time and caused such an alteration in the conditions of existence, that the species had to "flee for their lives." In the "struggle for existence" that followed, under new and more or less unfavourable circumstances, many were exterminated, and the majority of the survivors so changed that they are now considered different species from their ancestors. As I differ from Professor Ramsay in the first part of my answer, I ought to prove my assertion. This cannot be done better than by a quotation from his own Anniversary Address to the Geological Society, for the following year; it runs thus, "The majority of the forms that passed upwards from the Inferior Oolite limestone, seem to have fled the muddy bottom of the Fuller's Earth sea, and to have *returned to the same area*,† when the later period of the Great Oolite began." ‡ Here, therefore, Professor Ramsay acknowledges the occurrence of a recurrent fauna.

There is but one other phase of this question that I shall now endeavour to discuss, namely, that if widely separated strata apparently contemporaneous are not really so, it may be urged that it becomes almost a farce to attempt to correlate distant deposits, unless we have some golden rule with which to find out their difference in age. Mr. Salter has neatly enunciated this kind of scruple, by saying that "it is hard to have to question every conclusion as it arises," § and doubtless it is a very hard thing at first; but as all men of science love, or ought to love, truth more than apparent symmetry, they will soon get over this feeling, and in the meantime we must seek for a remedy to assist them in doing so. Such a remedy has been proposed by Professor Huxley, in his Anniversary Address

* Op. cit., p. 26.

† The italics are mine.

‡ Address Geol. Soc., 1864, p. 26.

§ 'Geol. Mag.,' vol. i. p. 5.

already quoted. He has suggested that instead of the term 'contemporaneity,' we should substitute a word that would express similarity of serial relation, but would exclude the notion of time altogether, and has proposed the term 'homotaxis' (similarity of order) as embodying that idea, and as a parallel to 'homology,' which is used in anatomy to express correspondence of position. This term 'homotaxis' was suggested in 1862, and as yet only one palæontologist of note, namely, Dr. Duncan, has used it in his writings instead of the terms 'contemporaneous' and 'synchronous,' neither of which conveys the exact meaning of those who, like myself, believe that the absolute contemporaneity of distant deposits cannot be strictly determined. But it is something for one high authority to have "broken the ice" within three years.

If 'homotaxis' is to be used instead of 'contemporaneity,' we must have its adjective, 'homotaxeous' as synonymous with 'contemporaneous;' and I cannot see any reason why these terms should be objected to on account of their novelty. Every new idea, like every new machine, must have a new name; and if the name has not been given until the idea has become tolerably familiar to us, there is greater reason why it should not now be objected to. There is also this additional consideration, that if our inferences are based on the 'homotaxis' of formations instead of their contemporaneity, there will be no necessity to "question every conclusion as it arises."

EXPLANATION OF THE PLATE.

Fig. 1. *Cyrena fluminalis*, fossil in the Post-pliocene deposits of England, Belgium, &c., recent in the Nile and some Asiatic rivers. Twice the natural size.

Fig. 2. *Argonauta hians*, fossil in the Sub-Apennine deposits of Italy, and ranging in the recent state as far as China. Natural size.

Fig. 3. *Eburna spirata*, fossil in the Miocene strata of Bordeaux, recent in the East Indian Ocean. Natural size.

Fig. 4. *Voluta strophodon*, M'Coy, MS., from the Miocene deposits of Australia. Natural size.

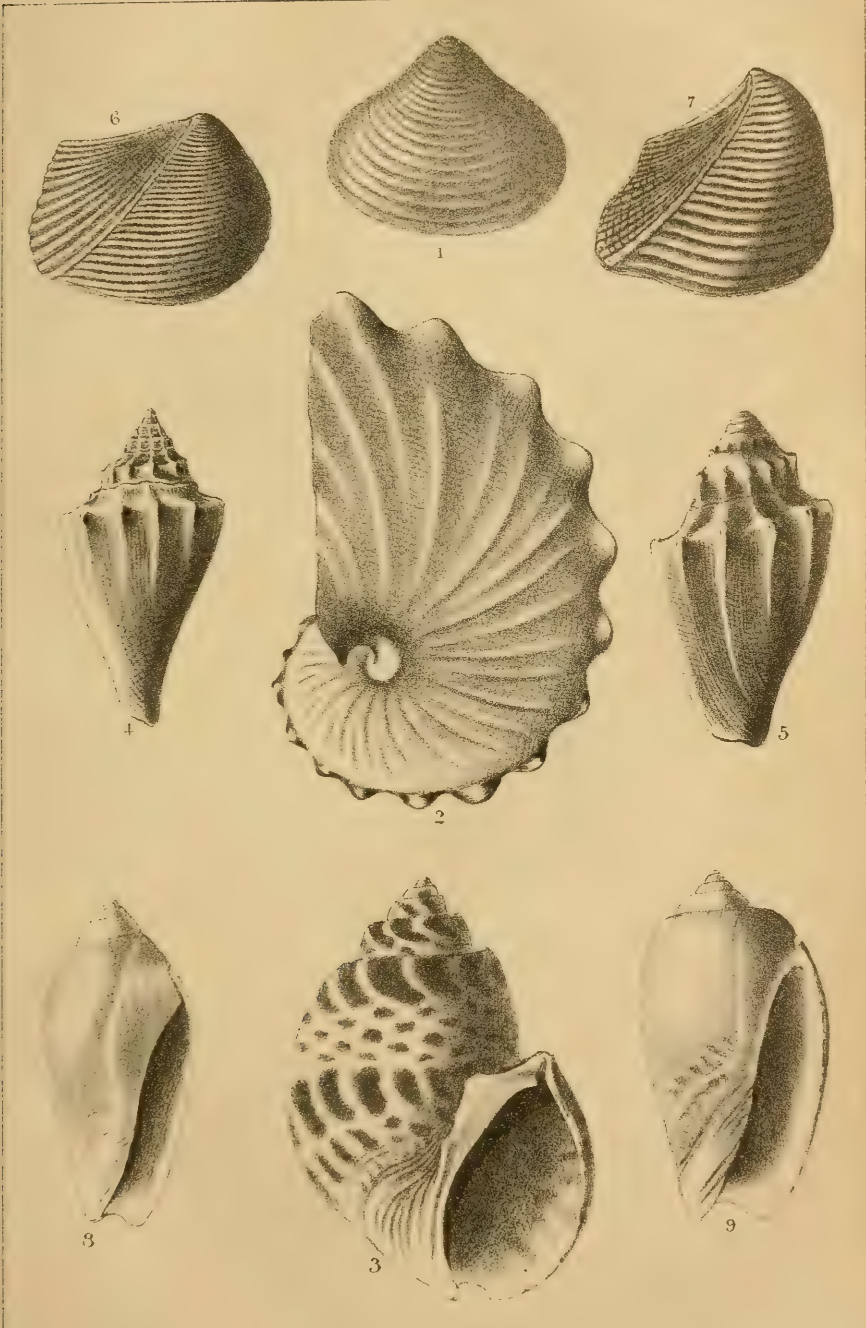
Fig. 5. *Voluta spinosa*, from the Eocene beds of England and France. Natural size.

Fig. 6. *Trigonia semi undulata*, M'Coy, MS., from the Miocene deposits of Australia. Natural size.

Fig. 7. *Trigonia costata*, from the Oolitic formations of England and the Continent. One-third the adult size.

Fig. 8. Adult Tertiary *Oliva*, from Java and Crete, apparently identical with the young of the existing *Oliva utriculus*. Twice the natural size.

Fig. 9. Full-grown specimen of *Oliva utriculus*, from Africa, showing the adult characters. Natural size.



De Wilde. lith. ad nat.

M & N. Hanhart, imp

FOSSIL SHELLS.

THE NORTH POLE.

By the Rev. C. W. KETT, M.A.

IT is not the province of Science to prophesy. It is perfectly possible from certain data to arrive at conclusions from which there is no escape in regard to many matters of exact science. Thus Adams and Le Verrier could both calculate from certain noticed observations of Uranus, that some attractive power in a particular position was influencing the orbit of that planet, and well-directed investigations towards this point afterwards discovered the planet Neptune in the position assigned. So far Science, where the influences were few, could demonstrate what afterwards proved to be a fact. But on this globe, though the laws of nature as we grow better acquainted with them seem fewer and simpler, their modifications nevertheless are so numerous, and the manifestations of them are so various, that the mind of man cannot as yet predicate with any certainty, that of which it is unable to make trial by experiment, or of which experience gives it no knowledge. It is not therefore with any pretence of foretelling what will hereafter be determined to be true or untrue, that the following lines are written, but with a view to place before your readers the various arguments that may be adduced in favour of there being either open sea, continuous ice, or snow-covered land towards the North Pole.

The prospect of an expedition in that direction naturally leads men's minds to speculate on what the explorers will meet with, and the necessity of preparation for any contingency compels those interested in these matters to compare the evidence that may be brought to bear on a point of such importance. But supposing the evidence either way were many times more conclusive than it is, we should not be justified in being unprepared for the other contingency, or in so far prejudicing our minds in favour of either hypothesis that we should find a difficulty in receiving any direct evidence of known credibility in the opposite direction.

Undoubtedly the common opinion with regard to the North Pole, is, that as in going northward from the equator to the arctic circle we find the cold gradually increasing, or, to speak more precisely, the heat decreasing, so if we go farther, a motion in the same direction still continues, and that thus by a simple progression sum we might calculate with somewhat of precision, the degree of cold that would be reached in a particular latitude. And again, to argue from the analogy of our nearest neighbour in the solar system, we have been enabled of late years to see that the planet Mars possesses climatic variations similar to those of the earth, and especially it has poles like our own, covered with ice and snow, descending in the winter nearer to the equator; and again in the summer assuming smaller proportions. Towards the extremity of the poles of Mars nothing has as yet been perceived which would indicate any modification of this constantly increasing cold; no spot has been noticed that would lead one to suppose that the snow was not continuous and

unbroken. Why therefore should we doubt that the same process takes place in our own planet? Simply, we may answer first, because nothing is more deceptive than to argue in physical science from what seems to be a well-chosen analogy.

Direct evidence seldom has the same weight as circumstantial, we shall therefore bring forward this our least trustworthy argument first: In the year 1818, Messrs. Barrington and Beaufoy, Fellows of the Royal Society, produced the evidence of several Dutch skippers, to the effect that they had succeeded in reaching within two or three degrees of the pole, that they had found there a sea of comparatively warm temperature, and that there was a swell which indicated no very close proximity of land. One man went so far as to declare that he had passed some two degrees beyond the pole. At this distance of time it is almost impossible to arrive at a very clear idea of the value of the evidence here given. Numerous skippers of whalers told tales of having approached and even passed the pole, after having penetrated the pack ice to the north of Spitzbergen, but whether these were the deliberate accounts of men who really believed that they had done as they had stated, or were mere travellers' tales, it is impossible now to say. And again, if these accounts were given in good faith it may well be doubted whether these men were not deceived through ignorance of some of the now well-known laws which govern the needle and other physical phenomena.

Soon after the last of these statements was made public, Baron Wrangel, accompanied by Lieutenant Matthiewskin, made several attempts to penetrate northwards from the coast of Siberia, but after having crossed some considerable space of ice, they were on each occasion met by open water, which checked further advance. This circumstance naturally drew men's attention to any fact which might lead to similar conclusions, and may well now draw our attention to the indirect but more trustworthy evidence.

A study of the condition of the sea about Spitzbergen has brought to light some curious results. It has been noticed that all the icebergs to be found in this locality consist only of frozen sea-water, not of masses detached from land-glaciers, as the icebergs of either coast of Greenland invariably are. Moreover, no terrestrial remains, according to the observations of Scoresby, occur on any portions of the ice to the north of Spitzbergen. To the east of that island less pack ice occurs than farther west. Sir Edward Parry (and this is direct evidence of a very different character from that mentioned before) advanced as far north as 82° 40′ North latitude, or within 7½ degrees of the pole, the highest latitude as yet reached in open sea to the north of Spitzbergen of which we have any authentic information, and when he was compelled to return he still saw open sea before him.

The narrow channels to the north of the Western Continent, into which innumerable ice-rivers pour their huge masses of frozen material continually, are soon blocked up by the icebergs thus formed, so that currents are stopped, the wind can affect them but slightly and that only at intervals, whilst in the meantime the cold attacks the intermediate spaces of undisturbed sea, and iceberg is linked to iceberg,

and channels are bridged across by plains of level ice which, even when crushed, piles up to form other icebergs, or, when rent asunder, leaves comparatively narrow fissures; these in their turn are spanned by a fresh coating of newly-formed ice. Throughout all the exploring ground that we know best, that namely to the north of the American continent and of Greenland, this is the constantly recurring cycle of events every winter. But farther east, to the north of Spitzbergen, the sea is more open, there is no trace of glacier action, no masses of ice are poured into the already freezing sea to form the nucleus of fresh congelation; the ocean currents are mighty, and wind wantons with waves, defying the ice particles, if formed, to adhere to one another.

The farther we proceed from the Western continent the more these conditions are increased: the Gulf Stream, in its mighty sweep across the Atlantic, ends not its course when it arrives opposite to the shores of our own island, nor even when it breaks against the rugged coast of Iceland. It separates certainly; the more westerly branch, verging towards the coast of Greenland, is soon merged in the south-flowing arctic currents—it turns on itself and is lost; but the more easterly continues its course and steers between the coasts of Iceland and of Norway on to Spitzbergen and beyond, until the impetus of this body of water is exhausted, but whether against the ice-wall in midst of the northern sea, or against the shores of the land on the other side of the pole, remains to be proved.

According to some of the greatest geologists of our time, there has been no geological period during which we can trace the effect of terrestrial icebergs descending from the arctic seas to the West of Spitzbergen. All along the coast of Europe, in England, Scandinavia, Germany, and Russia, erratic blocks of boulder-stones mark the progress of these early carriers; but to the east of the Ural, the results of their progress disappear, so that though we can scarcely believe that icebergs have not travelled southwards to the coast of Siberia, still they have brought nothing with them to mark whence they originated or where they settled; and if they brought no traces of the land about the glaciers from which they sprung, we may suppose that they were rather sea-born than of earthly parentage.

The effect of wind upon open water is very considerable, the force of rapidly moving air dashing against the uneven surface of the ice, even if not accompanied by a rise in the temperature, is very great, extending, as has been testified by numerous arctic explorers, even to the breaking up of extensive floes of ice from twenty to thirty feet thick. But besides the mere force of the wind in shattering these fields of ice, these storm-blasts are frequently accompanied by a rise of the thermometer, the wind coming from a warmer region. In the coldest parts of the earth the winds must almost invariably come from warmer climates; thus a predisposition to disintegration is produced, which, in combination with the violence of the wind, again works, and when once the ice is broken up, the sea itself is disturbed, waves of considerable height are raised, the water of various depths is intermingled, each depth having its own increasing temperature, until that

depth is reached in which is found the invariable marking of 39° Fahrenheit; and this water being brought to the surface, the air around is warmed and saturated with moisture, and finally we have the phenomenon of rain in the midst of an arctic winter. We have several records of such changes of temperature as are here referred to from the coast both of America and Asia, on opposite sides of the pole. Baron Wrangel speaks of a wind on the Siberian coast, from the S.E. by E. which causes a rise in the temperature from — 24° to + 25° or even + 32°. The Danish colonists of Upernavik, in North Greenland, say that frequently in the depth of winter they experience a warm south-easterly wind, which brings with it abundance of rain, a most unwelcome change of weather when they are only prepared to fence out cold. In the Private Journal of an officer of the 'Fox,' given in the first number of the 'Cornhill Magazine,' it is mentioned that late in December, when beset in the ice of Baffin's Bay, the daring voyagers experienced a warm wind from the N.N.W., and again Dr. Kane was met in January by what was at first a snow-storm, accompanied by much south-east wind, but which finally resulted in a thaw, indicating a rise in the thermometer of more than 70° in two days.

We may then sum up the evidence in favour of open sea northwards, for some considerable distance from Spitzbergen, into (1) the direct evidence of early navigators, principally Dutch, confirmed by the far more authentic evidence of Sir Edward Parry, as far as he went (82° 40′ N. lat.); (2), the absence of all evidence of land to the north of Spitzbergen, when such evidence might have been expected from icebergs or from the ordinary indications of land at some distance from the shore; (3), the confirmatory testimony of the power of ocean current, of open sea swell, and of storms of wind sometimes bearing heated atmosphere with them, stirring up the lower water of the ocean, which is known to be at all times at a fixed degree above freezing point. This evidence tends to prove that to the north of Spitzbergen no land interrupts the flow of the ocean, and that when the ocean is not divided into small channels, it is seldom entirely frozen over all the year round.

It is to be hoped, however, that an expedition northwards will ere long be fitted out, and that these speculations will then be set at rest, and that you will be able to place before your readers some more definite evidence as to the nature of both terrestrial and climatic condition of the country about the North Pole. In the meanwhile, should such an expedition as I have alluded to receive the sanction of Government, it must be remembered that whilst the route by way of Spitzbergen* holds out the inducement of a *probability* of open water for a great distance towards the hoped-for goal, we can arrive at no certainty until the expedition has taken place, and the explorers, whichever route may be chosen, must be *in utrumque parati*.

* Dr. Petermann, of Berlin, is so fully persuaded of greater feasibility of the route by way of Spitzbergen, that he has offered a premium of from 150*l*. to 300*l*. to any German mariner who will explore the ocean currents between that island and Nova Zembla, preparatory to an expedition to the pole from that quarter.

BRITISH GOLD,

WITH ESPECIAL REFERENCE TO THE GOLD MINES OF MERIONETHSHIRE.

By ROBERT HUNT, F.R.S.

THE discovery of Gold in Britain has, from the earliest recorded times, been a question of much interest. There is every reason for believing that before the Roman invasion this precious metal was known to the inhabitants, and prized by them. Julius Cæsar was induced to the invasion of these islands, from the report of the immense mineral treasure possessed by the people; and Tacitus, in his 'Life of Agricola,' distinctly tells us "in Britain are gold and silver and other metals." The early discovery of gold, even by ignorant men, is easily explained. It would be found in the beds of streams, left dry in summer, and the density and colour of the stone would very naturally attract attention. The metallic nature of the discovery would be readily detected by men who had already made themselves familiar with tin; and it is well to remember that all evidence is in favour of the belief, that tin from these islands formed an important element in the commerce of the eastern world, as early as the days of Solomon.*

Samuel Rush Meyrick† infers, from the 'Triad' which celebrates Caswallan, Manawydan, and Llew-Llawgyfes as three chieftains distinguished by the possession of golden cars, that the mines of North Wales were worked by the Cymri at a very early period.

Cimboline, Prince of the Trinobantes, is known to have coined money of gold, and the probability is that this was obtained in these islands.‡ The cross of Cong, the torcs, and various gold ornaments which have been found in Ireland, and which are preserved in Dublin and elsewhere, are remarkable examples of a tolerably advanced state of manufacture amongst, in other respects, a very unsettled people, and they prove the existence of gold amongst them in considerable quantities. It is thought by those who have examined the subject with care, that the gold was all found on the slopes of the Croghan-kinsella mountain, and in those streams which have made the county of

* Consult on this vexed question, 'History of Maritime and Inland Discovery,' by W. D. Cooley; 'Historical Survey of the Astronomy of the Ancients,' by Sir George Cornewall Lewis; 'Commerce and Navigation of the Ancients,' by W. Vincent, D.D.; 'Phœnicia,' by John Kenrich, M.A.; 'The Cassiterides: an Inquiry into the Commercial Operations of the Phœnicians in Western Europe, with particular Reference to the British Tin Trade,' by George Smith, LL.D., F.A.S. In the last quoted publication, a full and fair discussion of the whole question will be found.

† 'History and Antiquities of the County of Cardiganshire,' 1810.

‡ Sir John Pettus's 'Fodinæ Regales' supposes this gold to have been obtained in Essex. He writes, after having stated that Essex was within the region of the Trinobantes,—"This might be that mine which was afterwards discovered in Henry IV. his time in that countie." There is no evidence which would lead us to suppose that such a mine was ever discovered; but it is quite certain that this hypothetical gold mine created considerable sensation. "A letter of mandamus, issued by Henry IV., Mai ii., Anno. 2, Rol. 34, commands Walter Fitz Walter (upon information of a concealed mine of gold in Essex) to apprehend, &c., all persons that do conceal the same mine."—*Fodinæ Regales.*

Wicklow famous.* That the Romans discoverod gold in England and Wales is certain. We have the statement of Tacitus already quoted, and we have the evidence of the remains of Roman mines, which were worked for gold, in several parts of the country, the most remarkable being the gold mine—Ogofau or Gogofau—near Pumpsant, in Caermarthenshire. Here, situated on the left bank of the Cothy, and forming part of the grounds of Dolau-Cothy, are the curious remains of mining, which have been well described by Mr. W. W. Smyth.† For some distance the quartz lode has been "worked open to day," and galleries and levels have been driven 170 feet through the slate. In evidence of the auriferous character of this working, are the facts that the officers of the Geological Survey discovered gold in one of the quartz lodes at Dolau-Cothy, and that a metallurgical workshop was found; and amongst other curious remains a gold necklace, which is now in the possession of Mrs. Johnes, the wife of the gentleman to whom this property belongs. Other instances might be cited, if it were necessary, in proof of the former existence of gold in tolerably large quantities in many parts of these islands.‡

The streams which were washed in ancient times were, without doubt, exhausted of their treasures by the eager searchers, and hence the reason why we find traditions of the existence of gold clinging to spots where no gold can now be found. We have witnessed, within our own time, the exhaustion of many an auriferous district in California and in Australia, and without doubt the same process went forward in this country, as has been for some years active in those distant lands. Even now the "tin streams" of Cornwall are not entirely exhausted of their gold. From the earliest period the "streamer" has carried his "quill," in which he deposits the little spangles of gold, which from time to time present themselves to his discriminating eye. These quills of gold, when filled, are sold at the nearest town. Occasionally little nuggets have been found. In the Scorrier Collection of Minerals are two as big as small beans; and examples are to be found in other private collections, in Cornwall, in the British Museum, and in the Museum of Practical Geology, in London.

There has been a constantly prevailing idea that gold mines were to be discovered in this country, and we find our monarchs, with much avarice, claiming, under the term of "Mines Royal," the right to all the precious metals which might at any time be discovered. Sir John Pettus, who was especially the agent of Prince Rupert, thus defines a "Mine Royal:" §—

"When the ore does not yield so much gold and silver as will exceed the cost of refining and the loss of the baser metal, it is called a *poor mine*. But when the ore yields gold or silver to an

* See a discussion on this question, 'Transactions of the Royal Geological Society of Ireland,' 11th January, 1865.

† "Note on the Gogofau or Ogofau mine, near Pumpsant, in Caermarthenshire," by W. W. Smyth, M.A. 'Memoirs of the Geological Survey of the United Kingdom of Great Britain and Ireland.'

‡ See 'Lectures on Gold,' delivered in the Museum of Practical Geology.

§ Fodinæ Regales.

amount which will exceed the charge of refining and the loss of the baser ore, it is called a rich ore, or a *Mine Royal, and is appertaining to the king by his prerogative.*"

A few further notes on gold seeking in the British Isles will not prove uninteresting. In 1526 James V. of Scotland granted to certain Germans the right of working, under conditions favourable to the crown royalties, the gold and silver mines of that country for forty-three years. Elizabeth had previously made similar grants to Houghsetter, Thurland, and Schutz. In neither case, however, do we learn of any gold mines having been discovered. In one part of Devonshire those miners gave the names of "Gold Street" and "Gold Field" to spots where lead and silver, but no gold, are still found; and it is probable that they worked over the valleys near North Molton, in which the Britannia and Poltimore mines are situated. A few years since these mines gave rise to poetic prospectuses, speaking, almost singing, of "Pactolean streams flowing through the lovely valleys of Devonshire," and holding out the hope of "a realization of the fable of Colchis and the Golden Fleece." In 1593 James VI. of Scotland granted "Crawford and Glengomar to Thomas Foulis, goldsmith, of Edinburgh, for twenty-one years, in consideration of the great sums due to him, by his Majesty and his dearest spouse." This grant had especial reference to the reported discovery of gold in the Lead Hills district of Lanarkshire, and it was hoped would pay off the debt, 14,594*l.*, due to the Edinburgh goldsmith. We learn, however, incidentally from another authority that "the king expended 3,000*l.* on Crawford Moor and obtained not quite three ounces of gold." Pennant, however, says, on what appears to be very questionable authority, "in the reigns of James IV. and V. of Scotland was procured in the Lead Hills from gold washed from the mountains, especially in the reign of the latter, not less than the value of 300,000*l.* sterling." We are also told that a piece of gold weighing thirty ounces was then discovered. Sir Bevis Bulmer and five other gentlemen were empowered to work all the supposed auriferous districts of Scotland, and also the silver mine of Hilderstone, near Linlithgow, which was discovered in 1607. In 1616 Atkinson, a gold refiner, obtained a grant from the Privy Council, which was confirmed by James, "to search for gold on Crawford Moor, paying the king one-tenth." The inducements which were, from time to time, held out to capitalists to embark in the great gold adventure of the Lead Hills, clearly prove the unprofitable nature of the search for gold. The most amusing—as showing how skilfully the king and Atkinson ministered to human weaknesses—was an order of council, instructing Atkinson "to move twenty-four gentlemen of England, of sufficient land, to disburse 300*l.* each," . . . . for which they were to be created for ever "*Knights of the Golden Mines.*" Again and again the cry of gold has been raised, and the result has ever been the same—renewal of a large expenditure of money, the finding of but little gold.

After the Lead Hills the most notable example of gold-seeking has been in Ireland. In 1795 gold was picked up in the valley on

the flanks of Croghankinsella, and tolerably active workings were carried on by the Crown, under the direction of the Commissioners, Messrs. King, Weaver, and Middleton, until the Rebellion of 1798. The Crown during this period raised 944 ounces of gold, of the value of 3,675*l*. It was stated recently at a meeting of the Geological Society of Dublin, that a family named Byrne, who were farmers at Croghankinsella, found in the upper part of one of the rivers a mass of metal, about a pound and half in weight, which they supposed to be copper. It remained many years in their possession, and was used by them as a weight. They disposed of it at length to a travelling tinker, who carried it to Dublin, and sold it for a large price to a jeweller in Capel Street. This, or some such circumstance, led the Government to organize the commission for thoroughly examining the valleys of Wicklow. Dr. Haughton, at the meeting already referred to, said "the subject was a most interesting one, and the Society was the proper place for the discussion of it. The first point that occurred to him was the extraordinary manner in which the gold occurred in the localities referred to. The large 'model,' which had just been inspected by those present, represented a very celebrated Wicklow nugget, which some people said had been presented to George IV., but which others said that that monarch took the liberty of stealing out of this country. . . . . The peculiarity of it was that the gold appeared to consist of masses conglomerated or lumped together." This "model" represented the largest well authenticated nugget of rolled gold ever found in Europe, and which weighed twenty-two ounces.

Excellent descriptions of the Wicklow auriferous district will be found in a memoir by Mr. W. W. Smyth, which embraces also a careful examination of the mines of lead and pyrites.*

Such is a rapid outline of the history of the search for gold in the British Isles, and judging from the recorded results—these it must be admitted are few—it is not very encouraging. In nearly every case the ordinary process of washing has been alone adopted. It is true some mining works were unsuccessfully carried out in Wicklow, with the hope of discovering the quartz lodes, from which the gold was derived which had been found in the rivers. We have now to examine, with some degree of care, the progress of quartz mining, which has been carried forward for some years near Dolgelly, in Merionethshire.

In 1843 Mr. Arthur Dean discovered some rich gold ores at the Cwmheisian mines, not far from Dolgelly.† This gentleman's further researches are said "to have proved that a complete system of auriferous veins exist throughout the whole of the Snowdonian or lower Silurian formations of North Wales." Mr. Dean describes this most interesting district as consisting of an immense number of

* "Smyth on the Mines of Wicklow." 'Memoirs of the Geological Survey of Great Britain.'

† "Notice respecting the Discovery of Gold Ores in Merionethshire, North Wales," by Arthur Dean, C.E. 'Report of the Meeting of the British Association for 1844.'

alternate parallel beds of igneous and sedimentary rocks, traversed by mineral veins and trap dykes. A valuable paper on this subject will be found in the 'Transactions of the Geological Society of London,' to which we must acknowledge our debt for much of the geological information contained in this article.* The geological relations, according to this excellent authority, are as follows:—On the north and west of the lower part of the river Mawddach lie the lower part of the Lingula flags and the Cambrian rocks. The latter consist of the coarse, thick-bedded, greenish-grey grits of Barmouth and Harlech. Their upper boundary is marked by a sinuous line, which strikes in a north-easterly direction from Barmouth to Rhaiadr-Mawddach, and from thence trends northerly a little east of Transfynydd to the turnpike road, about a mile south of Festiniog. The line then strikes S.W. to Morfa Harlech on the coast of Cardigan Bay. These grits are overlaid by that part of the lower Silurian rocks, known as the Lingula flags, which here consist mostly of blue slaty beds, generally more or less arenaceous, and partly interstratified with courses of sandstone. A well-marked portion of the series, composed of rusty ferruginous slate, occupies part of the cliffs of Moel Cynwch, that overhang Dol-fawr on the Maddach. Both Cambrian and Silurian rocks have been penetrated by numerous greenstone dykes, some of which are magnetic. The following exact description of the metalliferous district is preserved in Professor Ramsay's own words:—

"Several lodes occur in this country in the neighbourhood of Dol-y-frwynog and Cwmheisian. The gold at Cwmheisian was discovered in 1843 by Mr. Arthur Dean, who, in a paper published in the 'Report of the British Association for 1844,' also stated, 'that a complete system of auriferous veins exists throughout the whole of the Snowdonian or lower Silurian formations of North Wales.' Recent events would seem, in a slight degree, to verify this bold assertion; but from that date to this time no one has heretofore attempted to work any mines in North Wales for gold, except that at Cwmheisian; nor have I ever met with any miner who has seen any gold of the alleged auriferous veins, with many of which I am also well acquainted. Cwmheisian has been worked several times, but, I believe, never with a steady profit. The gold is found in a branching lode, containing quartz with some iron pyrites. Its principal branch runs north-easterly, and is mostly composed of exceedingly hard quartz, which crosses the river about half-a-mile above Rhaiadr Mawddach. Another quartz lode, bearing lead, occurs a little above the waterfall. A north-west lead lode lies a little west of Moel-Hafod-Owen; and two others (one of them bearing silver) cross the river in the same direction, about half-a-mile below the fall. They pass through arenaceous slates and greenstone. Two north and south copper lodes cross the little valley that lies between Moel-Hafod-Owen and the hills behind Dol-y-frwynog. Two others occur on the steep slopes that overhang Afon-wen on the west, about half-a-mile south of Dol-y-frwynog. These four are in the talcose rocks above described. Several large quartz lodes traverse this country on Moel-Hafod-Owen. They are in the ordinary Lingula flags. The largest is on the east flank of the hill. The rocks are there much disturbed and altered, and numerous little bosses of greenstone are abundant among its beds.

* 'On the Geology of the Gold-bearing District of Merionethshire, North Wales. By Professor A. C. Ramsay, F.R.S.

"When I inspected the geology of this country in the spring of 1853, the most remarkable and promising lode was the new gold lode of Dol-y-frwynog. The lode runs W.N.W. and E.S.E. in the low ground south of Moel-Hafod-Owen on the east watershed. It is principally composed of a white saccharoid quartz, irregularly traversed by numerous small loose joints. Chlorite, decomposing talcose matter, and pink carbonate of lime, are intermingled with it. In parts the quartz assumes a semi-granulated aspect, profusely intermingled with soft unctuous decomposing talc. It is largely charged with iron pyrites. As a rule, the substance of the lode is easily shivered into fragments, a great advantage both in the original working of the lode and in subsequent operations. It was first opened in search of copper; and a shaft was sunk to a depth of about twenty fathoms. During the process, however, it soon proved to contain more attractive metal. On examining a heap of quartz which lay at the mouth of the shaft, and turning over a few pieces, I readily saw, with the naked eye, gold in small flakes and grains, irregularly disseminated through the quartz. In a more select heap of quartz, on all the pieces it was distinctly visible to the unassisted eye; and one mass in particular, heavier than a strong man could lift, was literally spangled all across its surfaces with rich glittering gold. Gold has also been detected by Mr. Byers in the matrix of the copper-bearing lodes about a mile further south, and in the west of Dol-y-frwynog lode, by the spot marked 'Turf Copper Mine' on the map of the Geological Survey. All these occur in the same talcose rock.

"On the banks of the Afon-wen, about a mile above the bridge, are some ruins of buildings, and below them, close to the river, the remains of charcoal ashes and bits of bones, mostly covered with herbage. This place has a very singular, and in conjunction with its late discoveries, a very significant name, which it has maintained from time immemorial, expressive of gold having been melted or worked there.

"This name, 'Merddyn Coch'r awr,' signifies 'the ruins of red gold.' The tradition is, that the Romans formerly worked gold there. It may be well to observe, to those unacquainted with Welsh names, that no ancient place has a name but what is characteristic of its locality, or of some event that has taken place on or near the spot."

Mr. Arthur Dean was evidently the first person who called attention to the system of quartz lodes, more or less auriferous, which have rendered this district remarkable. It is said, however, that a little gold was detected in one of the copper ore lodes in the year 1836. Of late Mr. Dean has been appointed engineer to the Vigra and Clogau mines, and this position has enabled him to study with much care the peculiar conditions under which the gold occurs in these quartz veins. These are especially deserving of the closest study—they are the only gold bearing rocks of this country—and the workings which are now in progress present opportunities which should not be neglected. Within an ellipse about fifteen miles long by twelve miles wide, are enclosed all the mines opened in the Dolgelly district. Outside this, other fields are found, the most promising being the Bala district, in which is situated the Castele Carn Dochan gold mine, which is now yielding, monthly, small quantities of gold. Nearly all the gold mines are opened in the lower Silurian beds, but in the Cambrian sandstones some of the quartz veins produce gold. The presence of greenstone or trap rocks has been already noticed;

and it is a fact deserving of note, that away from the vicinity of those rocks, no good gold lode has been discovered.

The most important gold mines in North Wales are the Vigra and Clogau, from which, as we stated in our Chronicles of Mining in our July number, 10,778 ounces of gold had been obtained to the end of 1864. For some years, both the Vigra and the Clogau mines were worked for copper. They are now united as auriferous quartz mines, but nearly all, if not all the gold, has been obtained from the latter.

The Clogau St. David, No. 1 mine, is certainly the richest gold mine ever worked in the British Islands, and may compare favourably with the quartz reef mines of Australia. According to Mr. Dean, from a space of ground not more than fifty fathoms long by thirty fathoms deep, and only a portion of which has been worked away, there had been extracted at the 31st of May last, and reduced 4,154 tons of quartz, yielding 11,508 ounces of gold, giving an average of 2 oz. 15 dwts. 19 grs. per ton. Taking this lode as a type of those which occur in its neighbourhood, it will be well to describe it.

The lode has an average bearing 15° N.E., and is intersected by a very powerful cross-course, bearing 30° N.W., and dipping slightly S.W. The lode traverses beds of indurated Silurian clay slate, which are interstratified with thick beds of greenstone. There is also a large greenstone dyke, which is traversed by a portion of the lode for a length of about sixty fathoms, until they are intersected by a great cross-course. Behind this cross-course the lode is extremely rich in gold. It should be stated that the lode is composed almost entirely of quartz, with here and there some carbonate of lime. Throughout the quartz, yellow copper ore is, in small quantities, disseminated as well as gold. Where the gold is most abundant, Telluric Bismuth in fine silvery white grains is generally present, and an opinion prevails that whenever that mineral is met with, gold is near at hand. It was commonly supposed that gold is only to be found near the surface. Mr. A. Dean has favoured us with some notes on this point, which are exceedingly important if all the conditions have been correctly observed. Without comment, Mr. Dean's own words are given :—

"The opaque white quartz floors, which are comparatively poor in gold, alternate with others of a greenish white colour, very dense, and of a shining conchoidal fracture ; the latter are the rich gold-bearing floors ; we have, therefore, alternate rich and poor floors. From the dip of the floors the deposits of gold appear individually to dip eastward, but, as the bands of clay-slate forming the walls of the lode below the greenstone dip westward down to the cross-course, the succession of bunches of gold in the alternate floors of greenish quartz follow the dip of the clay-slate. This is an important point in relation to the recurrence of rich deposits of gold in depth below the present bottom."

This quotation sufficiently indicates the hypothesis that with a recurrence of the same conditions in depth, rich, or perhaps richer, deposits of gold may be met with. There is a very close analogy between gold and tin. It was an opinion, held with much obstinacy for a long period, that tin would never be found deep in the earth. Experience has now proved the fallacy of this, for the most abundant

deposits of tin are now worked at depths of between 200 fathoms and 300 fathoms from the surface. The result of sinking on the quartz lodes in the mountains of Merionethshire will be watched with much interest.

Invariably when a good mine is discovered, a great many other mines are started in the neighbourhood. This applies to every variety of mine exploration, and is especially applicable to gold-mining. Numerous attempts and failures have hitherto marked the progress of mine-adventure in North Wales; and it is generally believed that more gold has been expended on the Welsh hills than has been obtained from them. The authority whom we have already quoted, speaking of the poorer varieties of quartz, says:—"The Clogau Company has stamped 2,500 tons of poor ores, yielding an average of 12 dwts. per ton; and during the last two months the Castele Carn Dochan Company has stamped 200 tons of the mineral broken indiscriminately from their lode, with an average of 15 dwts. of gold per ton. With good reduction machinery several of the gold mines in the Dogelly district might yet be made to pay." It will be most satisfactory to find the hopes thus expressed by Mr. Dean fully realized. It is right that some idea should be given of the occasional richness of this auriferous quartz. Mr. T. A. Readwin informs us* that by far the richest discoveries of gold have been made at the Dol-y-frwynog, Prince of Wales, and the Clogau Mines. He has, he states, extracted gold from stones, from each of those mines, at the rate of 300 to 400 ounces to the ton. At the same time as he draws attention to the exceeding richness of some specimens of the auriferous quartz, Mr. Readwin says, with much honesty, "I beg distinctly to state that the average yield will not, in my opinion, exceed half-an-ounce to the ton of ore."

Our readers will be familiar with the amalgamating process, by which gold is separated from the earthy minerals with which it is mixed. The extraction of gold by amalgamation is, however, attended with serious difficulties. Whenever Sulphides, Arsenic, Bismuth, or Tellurium are present with the gold, they frequently tarnish the metal, and the mercury cannot act upon it. Technical language informs us, that the mercury "sickens," that is, it grows thick, or that it "flours," meaning that it becomes pulverulent. These conditions are dependent upon the presence of other metals. Under either of those circumstances much of the gold escapes the influence of the mercury and is lost in the "tailings," whilst much of the mercury itself is carried off in the washings. Mr. William Crookes, F.R.S., the discoverer of the new metal Thallium, has introduced an improvement, which promises to be of the utmost advantage, in all our operations for obtaining gold in quartz-mining, or when it is combined with other minerals.

Mr. Crookes's process possesses the following important advantages:—By the judicious admixture of a certain proportion of Sodium with the mercury its amalgamating powers are, under all

* "On the recent Discovery of Gold in Merionethshire." By T. A. Readwin, F.G.S. 'British Association Reports for 1863.'

circumstances, preserved and intensified. It will extract gold from Sulphides, and from such other minerals as have hitherto resisted the ordinary process. It will seize upon gold tarnished by any of the metals named above, and which would pass untouched through common mercury and be lost. It will absolutely prevent "sickening" and "flouring," consequently the yield of gold is augmented, and a large saving in mercury is the result.

A series of experiments were made to determine the action of the sodium, under such circumstances as presented unusual difficulties, and the results of these trials were as follows:—

It should be stated that the mercury contained one per cent. of sodium.

1. When a little of the sodium amalgam was added to ordinary mercury, the affinity of the latter for gold was greatly increased, so that when pieces of gold were dipped into it they were instantly covered with mercury, although when dipped into mercury to which no sodium had been added, amalgamation was very slow, and difficult to obtain.

2. "Floured" mercury immediately ran together into a single globule, on the addition of a little sodium amalgam.

3. When iron pyrites (bisulphuret of iron), magnetic iron pyrites (sulphuret of iron), or copper pyrites (sulphuret of copper and iron), were triturated with sodium amalgam, the pyrites were decomposed, and on the addition of water, a black precipitate of sulphuret of iron was obtained.

4. Triturated with sodium amalgam—*a*, Arsenical pyrites was decomposed and arsenic amalgam formed; *b*, Galena (sulphuret of lead) was decomposed, and lead amalgam formed; *c*, Blende (sulphuret of zinc) was decomposed and zinc amalgam formed; *d*, Litharge (oxide of lead) and white lead (carbonate of lead) were decomposed and lead amalgam formed. An extensive series of experiments has been made at the mines near Dolgelly, and in every case, a considerable increase in the quantity of gold has been effected by the use of the sodium amalgam. The only thing which appears to be necessary to ensure the usefulness of the sodium amalgam in all cases, is a preliminary experiment to determine the quantity of sodium which should be used with the mercury. When too much sodium is employed it attracts the other metals present—in some cases to the rejection of the gold; but when judiciously applied it works with wonderful facility.* This discovery promises many advantages to the adventurers in the auriferous mines of Wales, and it will probably lead to the successful working of some of the poor quartz lodes through which the sulphides and arsenides of the baser metals are disseminated, and thus prove a solution of the problem, Can British gold be worked with commercial advantage?

* Since the above experiments were tried, Mr. Crookes has introduced a modification into his process, by which the ill effects of adding an excess of sodium are entirely avoided. The improved process has been thoroughly examined and experimented on by Dr. W. Allen Miller and other high authorities, and the results are said to be very striking.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

Professor Church, of the Royal Agricultural College, has published the results of some experiments instituted to ascertain whether the denser grains of wheat will yield a larger and better crop. The conclusions indicated were that seed wheat of the greatest density produces the densest seed and the largest amount of dressed corn; that seed wheat of a medium density generally gives the largest number of ears, but the ears are poorer than those of the densest seed; that seed wheat of medium density generally produces the largest number of fruiting plants; and that seed wheat which sinks in water, but floats in a solution having the density of 1·247, is of a very low value, yielding on an average only 34·4 pounds of dressed corn for every 100 yielded by the densest seed. These were the results given by experimental plots, in each of which twenty seeds properly selected had been planted. It also appears, from experiments on a larger scale, over plots of twenty to forty perches apiece, that an average return of about 13*s.* per acre is obtainable by submitting the seed sown to a process which shall separate from it the lighter corns; that a very high standard of density is not required to secure this extra return, the exclusion of about one-fifth of the ordinary seed corn being probably sufficient; and that the process of selection of seed in this way, according to density, is easy and inexpensive. On the whole of this series of experiments and their results, it is sufficient to remark that a single inquiry of this kind is altogether inadequate to determine or eliminate the really efficient agent or cause of the results that were obtained. And even supposing this not to be external, but to be resident in the seed itself that was selected with so much care, yet the density of the grain is most likely not the cause, but the mere concomitant of the cause, to which the results are properly attributable. It seems plain that the general character and habit of growth of a plant is to some extent inherited from the past and transferable to the future generation of it; but it is not so easy to believe that any such quality as density of seed is inherited or transferable. Such a quality must be due to the nutrition of the plant, by both soil and air, throughout the several stages of its growth, long after it has parted with the original mother-seed. And the farmer who knows how a heavy, starch-filled, full-sized berry, and a lean, horny, shrivelled sample of grain at harvest time are often both of them obtained from the very same seed corn—according to the quantity of seed he sows per acre, the condition of the field, and the circumstances of the weather during July and August—who therefore knows what are the principal and all-powerful agents in the production of a good sample of whatever sort he grows—will value at a very low rate that influence exerted by the density of individual seed corns, which, all other things being equal, may perhaps to some small extent be readable in the crop at harvest time.

Mr. Lawes, of Rothamsted, has reported in the Royal Agricultural Society's Journal, an attempt made to reproduce upon his farm the alleged experience of M. Hooibrenk in the artificial fertilization of wheat. That gentleman had declared in the *Journal d'Agriculture Pratique* that he had obtained a largely increased crop of wheat by an artificial fecundation of the plant conducted in the roughest possible manner. That this process is capable of being artificially directed is plain from the success of experiments in hybridising. If we cut out the anthers of one flower before the pollen has escaped, and substitute others full and just ready to burst, we ensure an artificial result. But the process is one of extreme delicacy, and needs to be most carefully executed. M. Hooibrenk's plan was, on the contrary, extremely rude. To a rope long enough to stretch across the plot to be operated on, pieces of woollen twist two feet in length are attached so close as to touch each other, thus forming a fringe two feet deep. Before using it, this fringe is smeared with honey, and the rope thus prepared is stretched across the plot, and trailed over the growing crop when in bloom in still weather. The idea is that the natural process of fertilization is often imperfectly accomplished, and that by this artificial contrivance an efficient aid is rendered which will make itself apparent in the crop. Mr. Lawes did not find it so. He had plots of land whose cultivation and produce had been so exactly recorded for twelve years, that he was certain of identical results from them under uniform treatment; but no results were perceptible from the adoption of M. Hooibrenk's process, even on such land where they would certainly have been seen. The honeyed fringe was drawn over each plot to be operated on, three times at intervals of forty-eight hours early in July, and the following table gives the produce obtained with and without the process of artificial fecundation.

Produce of Wheat per Acre on Duplicate Plots, one Artificially Fecundated and the other not. Harvest 1864.

Plots, &c.	Dressed Corn.			Offal Corn.	Total Corn.	Straw (and Chaff).	Total Produce (Corn and Straw).
	Quantity.		Weight per Bushel.				
	bs.	pk.	lbs.	lbs.	lbs.	lbs.	lbs.
12*a* Artificially Fecundated . .	44	1¾	62.6	99	2881	4315	7196
12*b* Not „ . .	44	3	62.4	93	2882	4356	7238
Difference	0	1¼	0.2	6	1	41	42
13*a* Artificially Fecundated . .	42	2¾	63.2	88	2786	4480	7266
13*b* Not „ . .	43	2¾	63.4	111	2882	4620	7502
Difference	1	0	0.2	23	96	140	236
14*a* Artificially Fecundated . .	41	0¼	63 1	149	2740	4003	6743
14*b* Not „ . .	41	3¾	62.8	110	2745	4107	6852
Difference	0	3½	0.3	39	5	104	109

In none of the trials was any increase of produce obtained by means of the fecundating process. Mr. Lawes very reasonably adds—"It may be remarked that it would seem our neighbours, the French agriculturists, are now going through a stage which in this country was passed through some few years ago. The artificial application of electricity, seed-steeping, and other marvels, which were to double the produce of our fields at little cost, have had their day with us; but the British farmer is still toiling on as formerly, earning his bread by the sweat of his brow and the liberal use of manure, without which he does not find his crops increase."

That the conditions under which the process of natural fecundation is effected do influence the productiveness of the crop, is almost every harvest plainly shown; but that any such rough and wholesale attempt at artificial assistance can be efficient is clearly impossible. The produce of grain crops at harvest time is, however, even more dependent on the weather and the soil throughout the other months of the plant life, than it is on such variations of weather as we suffer during July when they are in bloom; and thus, though we had a wonderfully fine latter end of June and commencement of July this year, during which the process of fecundation must have been most perfectly accomplished, the produce of our corn-fields is this year greatly deficient. A dry spring time, and one or two cold days in early June, seem to have made all light-land crops, and very generally the spring-sown crops on all sorts of land, deficient.

The 'Agricultural Gazette' has published the returns from its correspondents in the following terms:—

"Wheats on the lighter soils and loams are generally inferior, Barley on the lighter and thinner barley soils is much below an average, and, though probably the best crop of the year, it, too, as a whole, is inferior. Oats, excepting the few instances where winter sown, are the poorest crop we have had for many years. Beans and peas are generally below their usual yield."

The following is a tabular statement of the Returns:—

Number of Returns.

Crops.	Under Average.	Average.	Over Average.	Total.
Wheat . . .	76	90	29	195
Barley . . .	40	112	28	180
Oats . . .	154	27	2	183
Beans . . .	64	58	4	126
Peas . . .	37	67	6	110

The exceptions to the general failure are in the case of clay land wheats, and notably in that of wheats on the poorer clays, which is almost everywhere unusually good. The barley on the better class of barley soils is also a fair crop wherever early sown. Peas are a good crop in some districts.

The root crop is a great improvement through all southern and midland England over that of last year. Mangels are generally good, and

Swedes and other turnips are tolerably promising. In the North, and all over Yorkshire and Northumberland, they have, however, been destroyed by the grub. And there has been, especially in the cotswold country, an extraordinary abundance of the common earwig in the field, to which the failure of the turnip crop is in some places attributed.

Certainly the annual results of farm management can as properly claim a record in a scientific journal, as the methods and the circumstances to which they are due. Whether in the vegetable or animal world, they are the truest test and touchstone of what is sound or unsound in those scientific discussions upon agriculture which might seem to claim precedence here. It is on the farmer's own experience, after all, that he must depend for guidance, and not upon the teachings, however confident and unquestionable, of the man of science, absolutely correct though these may be under certain limited conditions, not those perhaps of the field or of the homestead on which the experience of the agriculturist depends. Thus it was, that when Mr. Chadwick, at the discussion some months ago before the Society of Arts, declared his preference of the views of chemists and sanitary philosophers and engineers and gardeners, to those of farmers, on the agricultural utilization of town sewage, he was very properly met by a vigorous assertion of the absolute sovereignty of agricultural experience in the decision of all agricultural questions; and Baron Liebig's declaration of the intrinsic worth of guano for plant growing, as being under 8*l.* per ton, was quoted as an illustration of the folly of any other guidance. Is guano, because so the chemist says, therefore worth rather less than 8*l.* per ton? No, it is worth rather more than 12*l.* a ton. This indeed Liebig called a 'fancy' price. On the contrary, it is the *real* price, as any one going into the guano market will find. Agricultural experience of guano during twenty years of a trade exceeding 1,000,000*l.* per annum, and over an acreage probably exceeding 1,000 square miles every year, has determined its real value to the farmer past all power of chemical authority to upset it: and it is this, not the opinion of the purely scientific man, which affords the only trustworthy agricultural guidance to the farmer.

We are now on the point of an attempt, on a very large scale, on the part of agriculturists to realize somewhat of the value which chemists tell us that town sewage possesses. The Metropolitan Sewage Company has been fairly launched, and will proceed at once to carry out its plans for enclosing the Maplin Sands from the sea, and for conveying London sewage thither; and we shall in a very few years know certainly all that living plants, upon the scale of agriculture, and under the circumstances of South Essex soils and climate can tell us of the real, as distinguished from the 'fancy' price which the great German chemist puts on diluted town drainage.

The Cattle Plague.—The statistics of agriculture are of the same commercial and practical, as well as scientific interest, with regard to the live stock portion of the farmer's property, as they possess in respect of his corn fields. This branch of the subject is indeed of

especial interest now. The price of butcher's meat is unprecedented. It is probably chiefly due to the small produce of cattle food which last year's climate gave us. There was little hay and hardly any roots, and the raw material of the meat manufacture being scarce, the quantity of the manufactured article is proportionably small and its price proportionably high. But we have now among us a contagious disease, which is destroying large numbers of beasts, and there is every prospect consequently of meat becoming even scarcer. The Russian rinderpest, imported early in June, has found in the London cowhouses and in many cowsheds elsewhere, circumstances under which its poison, rapidly spreading, is extremely destructive. But it is not confined to close and badly ventilated buildings, for in country districts—Hampshire, Sussex, Kent, Essex, Norfolk, Shropshire, and elsewhere—we hear of its occurrence and fatality where cattle have been grazing in the open meadows. It is almost always traceable to stock bought in the London market, which has brought the infection with it into the country. It is an extremely virulent and infectious bovine typhus, which has hitherto completely foiled all attempts at treatment.

The principal endeavour therefore seems to be to isolate the evil, and by the destruction and burial of cattle when once they are attacked, to kill the poison before it has had time to spread. There has thus been less opportunity for the treatment of the disease than is desirable. Orders in council have given power to veterinary inspectors to direct the destruction of infected cattle, and attempts have been made to isolate particular districts, by hindering transportation and by regulating sales. Altogether untouched by these arrangements, however, there can be no more fruitful source of contagion than town dung from infected cowhouses, which is widely distributed by railway and canal. And so subtle is the mischief, that animals not themselves liable to the disease, both sheep and men, it is said, can convey the virus from diseased to healthy stock by contact, first with the one, and then, even at a considerable interval of time, with the other.

Another attack of contagious disease occurred during July and August on a farm in Sussex, where a flock of sheep became infected with the ovine small-pox; but here the prompt destruction of the infected animals and complete isolation of the farm has been successful in hindering the spread of the malady, which seems to have at length died out. It is to be hoped that similar measures, vigorously taken with reference to the rinderpest, may be similarly successful, notwithstanding that its occurrence in quick succession in so many different localities greatly increases the difficulty of the task.

The Society of Arts have published a report on the cottage building question, which, although its subject is treated as especially affecting labourers in towns, must yet be noticed in our agricultural chronicle. They have not considered it necessary to collect proofs of the existing unfitness of the greater part of the dwellings of labouring men as habitations for respectable and well-conducted families, nor have they thought that any further proof was needed that the excessive overcrowding which now exists in such dwellings promotes crime and

immorality, harbours disease, and materially lessens the effective power of the working classes by injuring health and shortening life. Considering all these, and many other equally important facts as already sufficiently proved, the Society discussed the practical difficulties in the way of an adequate provision of good house accommodation on terms within the reach of the labourer's means. On one point in particular, which relates especially to cottages in country districts, the Society very properly declare that the alternative of charging the relief of the pauper on the parish or on the union in which he resides, is one which peculiarly affects the building of cottages in the country. The present system has long been found one of the greatest obstacles to the proper accommodation of labourers on the estates on which they work; and the Society were prepared to recommend an amendment of the law by the extension of the chargeability of the poor from the parish to the union. The same views on this important question have been, however, generally recognized by the Legislature, and it is probable from the course of recent legislation that they will be still further carried into operation.

With this exception most of the topics which came under the attention of the Society affect rather working men in towns than rural labourers, and we do not therefore quote at length those paragraphs in the report which relate to demolition of houses by railways, to workmen's trains, and to enforcing the sanitary laws. The following shortly are the results of their deliberations. They recommend:—

1. That corporations, limited owners, &c., should have increased power to sell land for the erection of dwellings for labourers, under conditions as to proper drainage, ventilation, and sanitary regulations.

2. That the public loan commissioners should be authorized to lend money, at a rate not exceeding $3\frac{1}{2}$ per cent. per annum, for building dwellings for the labouring classes, under suitable guarantees and with due regard to sanitary arrangements.

3. That in all future railway acts, and acts for local improvements, when houses inhabited by the working classes are destroyed under compulsory powers, such companies should be compelled to provide, within a convenient distance, other dwellings in lieu of those destroyed.

4. That the following amendments should be made in our sanitary laws:—

   a. That the appointment of inspectors of nuisances throughout the country should be compulsory.

   b. That increased power be given to the proper local authorities, to oblige builders of houses to provide adequate drainage and ventilation.

   c. That the medical officers of health should be irremovable without the consent of the Privy Council, and that the amount of their salaries should be subject to the approval of the same authority.

   d. That houses in which lodgers are taken, especially where particular rooms in a house are overcrowded, should be brought under more efficient inspection.

II. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

Attention has been again directed to the value which will accrue to Astronomical Science by an Arctic expedition to the Southern Pole, in preparation for the astronomical observations which will have to be undertaken in the year 1882, on the transit of Venus, the most favourable of all phenomena for solution of the noble problem of determining the sun's distance from the earth, provided that proper stations for the observation can be found. The Astronomer Royal has written a letter to Sir R. I. Murchison, President of the Royal Geographical Society, in which, referring to the late discussions at the Geographical Society in reference to a proposal for an expedition towards the North Pole, the author states that though there is no single point of great importance to be obtained, there are a number of co-ordinate objects whose aggregate would be valuable. Professor Airy then suggests that the field is open for another proposal, which would give opportunity for the determination of various results, corresponding in kind and in importance to those of the proposed northern expedition, though in a different locality, and would also give information on a point of great importance to Astronomy, which must be sought within a few years, and which it is desirable to obtain as early as possible.

In our last volume we gave several extracts from an elaborate paper by the Astronomer Royal, in which he very carefully discussed the circumstances of the coming transit, in reference to the selection of observation-stations. For the northern stations there will be no difficulty; they will be on the Atlantic seaboard of North America, or at Bermuda; all very favourable and very accessible. For the southern stations the selection is not so easy; the observation must be made on the Antarctic Continent; if proper localities can be found there, and if the circumstances of weather, &c., are favourable, the determination will be excellent; if those favourable circumstances do not hold, no use whatever can be made of the transit.

The Astronomical object of a Southern expedition has already been sufficiently explained in these Chronicles. In the event of such an expedition being undertaken, the precise determinations which have been indicated as bearing on the astronomical question must (from the nature of the case) take precedence of all others. But there would be no difficulty in combining with them any other inquiries, of Geography, Geology, Hydrography, Magnetism, Meteorology, Natural History, or any other subject for which the localities are suitable.

The author concludes his letter by requesting that Sir R. I. Murchison will communicate these remarks to the Royal Geographical Society, and take the sense of the Society on the question, whether it is not desirable, if other scientific bodies should co-operate, that a representation be made by the Royal Geographical Society to her Majesty's government on the advantage of making such a reconnaissance of the Southern Continent as has been proposed; primarily in the interest of Astronomy (referring to his official responsibility for

the importance of the examination at this special time); but conjointly with that, in the interests, perhaps ultimately more important, of geography and other sciences usually promoted by the Royal Geographical Society.

A most valuable contribution to astronomical photography has been made by Lewis M. Rutherfurd to the American 'Journal of Science.' He at first employed a reflecting telescope with a silvered mirror, but after numerous trials he was obliged to abandon the instrument, owing to several difficulties inherent in the employment of this kind of telescope. He has now constructed an object-glass, not achromatic as regards colour, but corrected solely with reference to the photographic rays. The correction of this has been rendered certain and tolerably simple by the employment of the spectroscope as a means of examining its achromatic condition.

The image of a star at the focus of a perfectly corrected objective would be a point, the apex of all conceivable cones having the object glass, or parts of it, as the bases. This point falling upon a prism would be converted into a line, red at one end and violet at the other, with the intermediate colours in their proper places. If, however, the different coloured rays are not all brought to the same focus, the spectrum will no longer be a line, but the uncorrected colours will be expanded to a brush, the width of which will be the diameter of the cone where intercepted by the prism. It will thus be seen that a simple glance at a star spectrum will indicate at once what parts of the spectrum are bounded by parallel lines and consequently converged to one focal point, and what parts do not conform to this condition, and also the amount of divergence.

On applying this test, it was found that an objective of flint and crown, in which the visual was united with the photographic focus (in other words, where the instrument could be focalized on a plate of ground glass by the eye, as in ordinary cameras), was a mere compromise to convenience, in which both the visual and actinic qualities were sacrificed.

In order to bring the actinic portion of the spectrum between parallel borders, *i. e.* to one focus, it is necessary that a given crown lens should be combined with a flint which will produce a combined focal length about one-tenth shorter than would be required to satisfy the conditions of achromatism for the eye, and in this condition the objective is entirely worthless for vision.

Having obtained the achromatic correction, the most delicate task was to produce the correction for figure, since the judgment of the eye was useless unless entirely protected from the influence of all but the actinic rays. A cell of glass, enclosing a sufficient thickness of cupro-sulphate of ammonia, held between the eye and the eye-piece, enabled the author to work for coarse corrections upon α Lyræ and Sirius, but so darkened the expanded disc of a star in and out of focus that all the final corrections were made upon tests by photography, which gave permanent record of all the irregularities of surface to be combated. Still, however, the process was long and tedious, dependent

upon but three stars as tests, and they too often obscured by bad weather. The mode of correction was almost entirely of a local nature, such as practised by the late Mr. Fitz and Mr. Clark for many years.

The objective was completed about December last, and the corrections of it are such that it is thought to be capable of depicting any object as seen, provided there be sufficient light, and no atmospheric obstacles. As respects the light; the objective has given photographic images of stars, designated by Smyth as of the $8\frac{1}{2}$ magnitude, and other stars on the same plate of full a magnitude lower. In the cluster Prœsepe, within the space of one degree square twenty-three stars was taken, many of which are of the ninth magnitude, with an exposure of three minutes. An exposure of one second gives a strong impression of Castor, and the smaller star is quite visible with half a second. With an achromatic objective it was necessary to expose Castor ten seconds to obtain a satisfactory result.

The great obstacle which prevents the results of photography from realizing the achievements of vision is atmospheric disturbance. In looking at an object the impression is formed from the revelations of the best moments, and it is often the case that the eye can clearly detect the duplicity of a star, although the whole object is dancing and oscillating over a space greater than its distance. The photograph possesses no such power of accommodation, and the image is a mean of all the conditions during exposure. It is, therefore, only on rare nights in our climate that the picture will approach the revelations of the eye.

Up to the date of the author's paper only one night had occurred with a fine atmosphere, and on that occasion the instrument was occupied with the moon; the negatives were described by the author as being remarkably fine, and superior in sharpness to any he had yet seen. The exposure for the phase three days after the first quarter is from two to three seconds, and for the full moon about a quarter of a second. Its powers have not yet been tested upon the close double stars, 2″ being the nearest pair it has been tried upon. This distance is quite manageable, provided the stars are of nearly equal magnitude. The power to obtain images of the ninth magnitude stars with so moderate an aperture, promises to develop and increase the application of photography to the mapping of the sidereal heavens, and in some measure to realize the hopes which have so long been deferred and disappointed.

It would not be difficult to arrange a camera-box capable of exposing a surface sufficient to obtain a map of two degrees square, and with instruments of large aperture we may hope to reach much smaller stars than have yet been taken. There is also every probability that the chemistry of photography will be very much improved, and more sensitive methods devised.

Proceedings of the Royal Astronomical Society.

Professor Wolf has presented a paper on the course of the sun-spot phenomenon, in which he discusses the statements made by himself

and other observers as to the relation in which sun spots stand to the planets. In 1859, when he sought by means of a formula dependent on the periods and masses of the four planets *Venus*, *Earth*, *Jupiter*, and *Saturn*, to represent a curve analogous to the sun-spot curve, he stated that Jupiter determines the leading character of the Sun-spot curve, that Saturn causes small alterations in the height and length of the undulations, and that the Earth and Venus determine the indentations of the curve.

As subsequent observers have drawn attention to the connection between sun-spots and planets, especially Jupiter and Venus, Professor Wolf has in this paper given some statements as to the connection between the sun-spot period and the revolution of Jupiter. A table is given in which it is seen that the period 11·11 completely satisfies what is only to be expected from a mean period affected with the considerable oscillation, 1·75; and not only there corresponds to the mean course thereof a good wave line with the difference, 42·96, between maximum and minimum, but the single maxima and minima accord well together, with only a slight displacement of the minimum of 1783 and the maximum of 1786.

A new arrangement of two solar prisms for use with a micrometer has been described by the Reverend W. R. Dawes. The transparent glass diagonal, suggested by Sir J. Herschel, is a very valuable adjunct in observations where it is desired to determine the relative situations of solar spots by means of a micrometer, as it permits a large aperture to be employed without danger to the dark glasses. But a very considerable difficulty arises from the fact that the relative positions of the spots and of the points of the compass, as thus seen, are different from their positions as they appear in the astronomical refractor. To remedy this inconvenience, Mr. Dawes has been in the habit of combining *two* pieces, each of which had a transparent glass diagonal, capable of being used separately or together. By this simple contrivance the image as reflected from both the combined prisms is seen in the direction of the axis of the telescope, and its various parts are in the same relative positions as when no diagonal is used.

At the June meeting of the Society, Mr. Dawes also gave a paper on the planet Mars, in which numerous curious and interesting features were described, such as the long, narrow strait, running N.E. and S.W. in the northern hemisphere; an oval bay with a regular coast, in which lately a distinctly forked appearance was noticed, giving the impression of two very wide mouths of a river which, however, he could never trace. Speaking of the colour, the author considers that nothing can more fully prove that the ruddy tint of Mars does not arise from any peculiarity in the colour of the planet's atmosphere, than the fact that the redness is always deepest near the centre, where the atmospheric stratum is thinnest; while near the edge of the planet the grey features are obscured, and in general entirely hidden, by the density of the atmosphere, and yet the colour

reflected from it is *white*, or *greenish-white*. The greenish tinge may possibly arise from contrast with the ruddy centre.

On the whole, the impression appears to be, that Mars has not usually a very cloudy atmosphere. During the last opposition the permanence and nearly equable distinctness of the principal features under similar circumstances was surprising. On no occasion could Mr. Dawes satisfactorily make out that any part was decidedly less distinct than might be expected from the appearance of the other features then visible.

Another paper by Mr. Dawes was on an aperture-diminishing eye-piece and a photometer of neutral tint glass. By the former arrangement the aperture of the object glass can be virtually diminished to any desirable extent without disturbing the telescope to vary the aperture on the object glass. The great convenience of this arrangement is too obvious to need further comment.

The other photometric arrangement consists in the addition to the solar eye-piece of one or more sliding wedges of neutral-tint glass; the obscuration extending from the smallest possible to what is usually sufficient for the Sun. A capital advantage of this arrangement is, that the small apertures in the diaphragm of the solar eye-piece enable one of the components of a double star to be excluded from the field while the brightness of the other is measured:—obviously a very necessary precaution where the stars differ greatly in brightness. As an example, it may be stated that the very small star near α *Lyræ* appears, when the large star is in the field with it, to be about of mag. 11·2 of Struve's scale; but, on excluding the large star, it rises to about 9·7, a difference of $1\frac{1}{2}$ magnitude. In the same way the comparative brightness of different portions of the Moon may be determined by isolating them in a small field. Thus also the brightness of the solar illumination of our atmosphere may be compared with that of the photosphere of the Sun itself, and also different parts of the photosphere.

Some good observations on the photosphere of the sun have been communicated by Mr. Fletcher. He comes to the conclusion that the appearance of the interlacing of long, flat, lenticular-shaped objects is due to a tremulous atmosphere, for the moment the atmosphere became steady the appearance vanished; and when vision was most perfect the idea of interlacing could not be entertained. The result of this examination of the sun's disc with an instrument of unexcelled defining power and under atmospheric circumstances such as rarely occur, is a strong impression that the granules are not "entities" at all, but portions of the sun's luminous envelope raised high in the outer and non-luminous atmosphere.

Some very elaborate observations on the solar photosphere and sun-spots follow by Mr. Brodie and Mr. Lockyer. Each of these papers is illustrated with woodcuts. The former gentleman's observations appear to show that the *rice-grains* and *willow-leaves* must not be confounded with each other, as (according to Mr. Nasmyth's

measurements) the latter must be about thirty times smaller than the former; on some occasions the outlines of some of the elevations were so clearly and sharply defined, that they could be compared to the appearance of a *coarse shingle beach.* During an examination of the sun through a red haze, which was found extremely favourable to definition, a number of the rice-grain forms were noticed lying in various directions one with another; the length of some of them being estimated at 8″ or 10″ and about 2′ in width. These waves, or ridges of photospheric cloud, were not of equal elevation throughout their entire length, but seemed to have an irregular outline of elevation, such as a cumulous cloud generally presents, so that the top of the very wave, or ridge, that causes the mottled appearance on the sun was itself most irregular in the outline of its upper surface. The sides of these waves, or ridges were of very great inclination, not very greatly removed from the perpendicular; the indentations, or valleys, between them intersecting each other most irregularly. In some parts of the photosphere, where the rounder forms prevailed, the indentations seemed very deep, and penetrated the cloudy stratum in such a slanting position, that the bottom of them could not be seen.

These indentations seemed to be *at least* 2″ in depth, or 1,000 miles, but the estimation of their profundity is a difficult matter. The tops of the ridges were the brightest, while the valleys, or indentations, appeared somewhat shaded and less luminous. On some occasions these were noticed, speckled with black dots, or pores. The whole of this mottled surface seems to be disposed in the form of huge undulations, very similar to ranges of mountains, as shown on a good map; the elevated portions appearing as *minute faculæ*, but far smaller, and far more difficult to observe, than the ordinary faculæ of the Sun.

Mr. Brodie has given an interesting account of the progress of an unusually wide bridge of luminous matter, which formed completely across a large oval-shaped spot, in the course of a few hours, showing the extreme mobility of the sun's photosphere. The luminous matter which formed the bridge, must have moved at the enormous velocity of 14,000 miles per hour. Mr. Brodie concludes, that from what he has observed of the Sun's surface, he cannot conceive the possibility of any regular form of particles so interlacing themselves together as to form the wonderful *nodosity* of the photosphere of the Sun, since any such interlacing would apparently necessitate a *comparative evenness and uniformity of surface*, and so far as he has been able hitherto to see the peculiar formation of the Sun's envelope, he has been as unable to reconcile the *willow-leaf theory* with it.

Mr. Lockyer's observations are devoted to one spot, which appears to have been remarkable in several respects; at one part a bright tongue of facula stretched out into the umbra, in the centre were what appeared to be clouds, which after a time appeared to condense into willow leaves; at another side was a promontory, in which the willow leaves were changing the direction of their larger axes, with respect to the centre of the spot, whilst in another part, the penumbra seemed composed of layers, and the willow leaves were arranged like

feathers on a duck's wing. Mr. Lockyer quotes the following paragraph from a letter recently published by M. Chacornac :—

"Having had the occasion formerly to observe small pieces of silver bathed in borax, melting under the influence of the blowpipe, I have always in my descriptions compared the 'crystals' of the photospheric matter to this silver solder in a state of fusion. Of the same opinion as Mr. Dawes, I hold that 'straws' at present are the objects which give the best idea of the appearance of the objects of which the whole solar photosphere consists. On the other hand, I do not find that in the many notes, and especially in those of Father Secchi, containing observations of this nature, is mention made of any important phenomena presented by these incandescent 'willow-leaves' or 'rice-grains.' As it is inherent in the nature of this matter, I will endeavour, as concisely as possible, to state in what it consists. If we observe a 'crystal' of photospheric matter, which is completely isolated and projected on a dark portion of a spot, for instance, it will be seen that for a certain time it diminishes in volume and becomes spotted over with small dark pores; that it is subdivided into numerous crystals, as if the photospheric matter were being volatilized, or as if there were a reabsorption going on, absolutely in the same way as crystals of sugar melt under a current of steam."

III. BOTANY AND VEGETABLE PHYSIOLOGY.

(*Including brief Notices of recent Botanical Works.*)

Casimir de Candolle has investigated the theory of a single angle of Phyllotaxis, or leaf-arrangement. He considers the views of Schimper, Bravais, and Martins, and afterwards endeavours to show that the single angle will explain leaf divergence. On the same branch we observe successively a series of Cycles belonging to orders of a less and less high number, in proportion as the axis of the branch is elongated and all the successive Cycles correspond to the terms of a series of the form :—

$$\frac{p}{q}, \qquad \frac{r}{s}, \qquad \frac{p + n r}{q + n s}, \qquad \frac{r + (p + n r) n'}{s + (q + n s) n'},$$

These fractions are evidently the successive reductions of a continuous fraction of the form :—

$$\cfrac{1}{a + \cfrac{1}{b + \cfrac{1}{n + \cfrac{1}{n' - - - -}}}}$$

These series of Cycles, which are found in different plants or on different parts of the same plant, correspond each to one and the same angle of divergence which the eye detects more or less completely, according to the greater or less approximation or condensation of the leaves. We may thus take for the value of this angle either

the highest term of each series or the limit towards which this series tends. In the former case we admit a single rational angle, which must be changed for another so soon as we find a higher term of the same series. In the latter case we admit a single irrational angle, which will explain all the phenomena whether present or to come.

Botanists have been apparently alarmed at the term *irrational.* It simply means that any one leaf is not rigorously superposed over another. May there not be some anatomical reason which demands that the leaves, at the time when they are produced close to each other on a vegetative cone, should not be exactly superposed? Admitting the theory of a single angle, we shall see that of all those which exist in nature, the greatest is that of the most common series:—

$$\frac{1}{2} \quad \frac{1}{3} \quad \frac{2}{5} \quad \&c. \; . \; . \; . \; . \; .$$

This is the angle in which the surface of the stem will be most nearly equal for both sides of the same leaf. Botanists have observed that in the case in which the laminæ of the leaf are not symmetrical, their greatest development takes place beside the greatest angle. If, as is said, the angle corresponding to the other series is more frequent in fossil plants, may not this frequent occurrence of the larger angle between $\frac{1}{2}$ and $\frac{1}{3}$ indicate a tendency towards a great symmetry of the laminæ?

The fact that the angle comprehended between $\frac{1}{2}$ and $\frac{1}{3}$ is common to almost all Phanerogamous plants, as well as to a great number of Cryptogamous plants, seems to mark a oneness in the origin of all these plants.

Dr. W. Nassau Lees gives a satisfactory report of the cultivation of Cinchonas in the valley of Kangra, Punjab, the most northern locality yet tried. The species introduced are Cinchona succirubra, C. Condaminea, C. micrantha, C. Calisaya, and C. Peruviana, received from the Neilgherry hills.

The cultivation of Cinchonas at Darjeeling is also going on favourably, under the direction of Dr. T. Anderson, Superintendent of the Botanical Gardens, and in charge of Cinchona cultivation in Bengal.

In the 'Appendix to the Journal of the Asiatic Society of Bengal,' No. 123, is a classified list of naturalists and others engaged in the collection of specimens of Natural History, Coins, &c., with notes and queries. The names entered under the departments of Zoology, Botany, Geology, Ethnology, and Coins, are only forty-six, but there are obvious omissions, as T. Anderson and Brandis among Botanists, Jerdon and Walter Elliot among Zoologists. The periodical publication of such a list, indicating the special branches of science which savans scattered over our Indian empire are pursuing, is calculated to be of much service, and we hope that it is a step towards the organization of an annual meeting for the promotion of science generally.

Flowering Plants of the Jardin *of the Mer de Glace of Chamounix, as given by Charles Martins.*

[The species marked with an asterisk (*) are found also in Lapland, those in italics occur also on the summit of the Faulhorn.]

The *Jardin* is about 9,043 feet above the level of the sea; its length is 2,625 feet; its breadth about 985 feet; its distance from the nearest rocks on which some plants grow is at least 2,625 feet. The *Jardin* is a group of Protogene rocks, projecting between the two affluents which form the *Glacier* of Talefre.

**Ranunculus glacialis*, L.; **R. montanus*, Willd.; R. Villarsii, DC.; *Draba frigida*, Gaud.; *Cardamine bellidifolia*, L.; C. resedifolia, L.; Sisymbrium pinnatifidum, DC.; Silene rupestris var. sub-acaulis, L.; **S. acaulis*, L.; *Spergula saginoides*, L.; Arenaria rubra, L.; A. serpyllifolia, L.; A. nivalis, Godr.; **A. biflora*, L.; *Cherleria sedoides*, L.; *Stellaria, cerastoides*, L.; **Cerastium latifolium*, L.; *C. alpinum, DC.; var. lanatum; **Spergula saginoides*, L.; Trifolium alpinum, L.; **Sibbaldia procumbens*, L.; *Geum montanum*, L.; *Potentilla aurea*, L.; *P. glacialis*, Hall; *P. grandiflora*, L.; *Alchemilla pentaphylla*, L.; **Epilobium alpinum*, L.; *Sedum atratum*, L.; *S. repens*, Schl.; *S. annuum, L.; Sempervivum montanum, L.; S. arachnoideum, L.; **Saxifraga stellaris*, L.; *S. aspera*, L.; *S. bryoides*, L.; Meum Mutellina, Gærtn.; *Gaya simplex*, Gaud.; Bupleurum stellatum, L.; Cacalia alpina, Jacq.; C. leucophylla, Willd.; *Tussilago alpina*, L.; **Erigeron uniflorus*, L.; **E. alpinus*, L.; *Pyrethrum alpinum*, Willd.; **Omolotheca supina*, Cass.; *Gnaphalium dioicum, L.; *G. alpinum, Willd.; Arnica montana, L.; Senecio incanus, L.; *Cirsium spinosissimum*, Scop.; Leontodon squamosum, Lam.; *L. aureum*, L.; Taraxacum lævigatum, DC.; *Hieracium alpinum, L.; H. angustifolium, Hoppe; H. glanduliferum, Hoppe; H. Halleri, Vill.; *Phyteuma hemisphæricum*, L.; Campanula barbata, L.; Primula viscosa, Vill.; Gentiana purpurea, L.; G. acaulis, L.; G. excisa, Presl; *Linaria alpina*, DC.; **Veronica alpina*, L.; *V. bellidioides*, L.; *Euphrasia minima*, Jacq.; Plantago alpina, L.; **Salix herbacea*, L.; *Juncus Jacquini*, L.; *J. trifidus, L.; Luzula lutea, DC.; *L. spadicea*, DC.; **L. spicata*, DC.; *Carex curvula*, All.; *C. fœtida*, Vill.; *C. sempervirens*, Vill.; C. ferruginea, Scop.; **Phleum alpinum*, L.; Anthoxanthum odoratum, L.; **Agrostis rupestris*, All.; *A. alpina*, Scop.; *Avena versicolor*, Vill.; *Poa laxa*, Hæncke; P. laxa var. flavescens, Koch.; **P. alpina*, L.; *P. alpina* var. *vivipara*, L.; Festuca Halleri, All.

There are thus 87 flowering plants on the *Jardin*. To these we have to add 16 Mosses, 2 Hepaticæ, and 23 Lichens, making a total of 128 plants which are found growing on this islet of vegetation surrounded by perpetual snow. Of the 87 flowering plants 50 are marked in italics, as being found also on the Faulhorn, an isolated Alpine summit. These florulas may represent well Alpine vegetation at its highest limit. Of the 87 species, 5 form a part of the Spitzbergen Flora, *viz.*:—Ranunculus glacialis, Cardamine bellidifolia, Cerastium alpinum, Arenaria biflora and Erigeron uniflorus; while 24 are found in Lapland. The subnival flora of the Alps corresponds to that of

Northern Lapland, as, for instance, about Altenfiórd; while to find a vegetation analogous to that of Spitzbergen we must ascend on the Alps above the limit of perpetual snow.

Botanical Excursion to Eastern Lapland.

M. Fellman, accompanied by MM. Brenner and Laurin, students of the University of Helsingfors, and a pupil of the Botanic Garden of the University, made a trip to Lapland lately, and collected about 300 species of Phanerogamous plants, 20 species of Ferns, and several Lichens. The party proceeded from Sordavala to Petrosavodsk, Kiwatsch, and Suma on the southern coast of the White Sea. Afterwards they went to the islands of Solovetskoi, and to Kem and Keret on the western shore of the White Sea. The Gulf of Kantalaks, and Umba, a Russian village on the southern coast of the peninsula of Lapland, were then visited. In this valley the people live by fishing; no part of the land is cultivated, if we except the western side, where some potatoes are raised. About six leagues east from Umba is the small peninsula of Turii, the western coast of which is granitic and rocky, while the east is flat and sandy as far as Pialitsa, where some clay and a few rocks are met with. The forests of the southern coast of Turii consist of Birch and Spruce. The latter attains here the height of 25 feet, with a circumference of 2 feet. *Pinus sylvestris* does not bear the maritime climate, but retires about two leagues from the sea. The vegetation of this desert region consisted of *Cladonia*, *Stereocaulon*, *Platysma nivale*, and *Empetrum nigrum*: in some humid spots are found *Salix glauca* and *S. phylicifolia.* Such treeless deserts are here called *Tundra.* Baer divides them into *Flechten tundra* (dry tundra), where Lichens predominate, and *Moos tundra* (moist tundra), where Mosses, especially *Sphagnum* and *Polytrichum*, abound. Besides the plants mentioned the following also occur:—*Arctostaphylos alpina*, *Calamagrostis neglecta*, various species of *Festuca*, *Carex ampullacea*, *Eriophorum angustifolium*, *E. vaginatum* and *E. alpinum*, *Betula nana* and *Juniperus communis.*

The travellers proceeded to Ponoi, situated on a river of the same name, the banks of which presented a luxuriant vegetation. Eighteen days were spent in the examination of the Flora of Ponoi. Among the plants collected may be noticed the following:—*Poa cæsia*, *P. sudetica* var. *remota*, *Eriophorum Callithrix*, *Luzula hyperborea*, *Gentiana tenella* and *G. nivalis*, *Pæonia anomala*, *Androsace septentrionalis*, *Pedicularis sudetica*, *Armeria arctica*, *Thalictrum rariflorum*, *Eutrema Edwardsii*, *Draba hirta*, *Arenaria ciliata*, *Cotoneaster vulgaris*, *Aira alpina*, *Juncus glaucus*, *I. castaneus*, *Aster sibiricus*, *Ligularia sibirica*, *Hedysarum obscurum*, *Cineraria campestris*, *Veratrum lobelianum*, *Aconitum Lycoctonum*, *Senecio octoglossus*, *Vicia sylvatica*, *Daphne Mezereum*, *Lychnis alpina.* The common heather, *Calluna vulgaris*, is not seen at Ponoi.

The inhabitants of Ponoi are half Russians, half Laps; they live together in harmony. On the southern side of the Peninsula the population is entirely Russian. During the summer the Lap-

landers from the interior of Russian Lapland betake themselves to the shores of the White Sea for fishing. From this they derive their chief means of subsistence. They do not drink the milk of the reindeer, nor do they make cheese from it, as is the case in Finland and Swedish Lapland. The inhabitants of the more western parts of East Lapland (who are called Kiwi-Lappalaiset, or stony Laps) do not betake themselves to the sea during summer, but remain beside their lakes and rivers. They are poorer than the others. The Russians inhabiting the southern coast have the reindeer as well as cows and sheep. The Lap is fond of tobacco, while the Russians of the old faith (Staroverts) consider it a sin to use this drug, and never smoke it. Both nations are fond of ardent spirits. In a single village, consisting of sixteen families, 1,000 vædro (about 2,860 gallons) of brandy are annually consumed.

The party did most in the way of collecting plants at Ponoi. Leaving it they journeyed slowly along the northern coast of the peninsula of Lapland and reached Kola. They then proceeded to *Paanajœrvi*, on the frontier of Finland, and returned to Helsingfors, after having traversed 700 leagues. From Keret to Kola around the Peninsula of Lapland is 225 leagues. Among the plants collected at Kola and near Swætoi-nos (*promontorium sanctum*) the following may be noticed, *Astragalus oroboides*, *Zannichellia polycarpa*, *Pedicularis verticillata*, *Atriplex patula* var. *hololepis*.

M. Fellman remarked that *Zostera marina* was found all along the western shores of the White Sea. In Eastern Lapland the only Alder which was seen was *Alnus pubescens ;* it disappeared to the north of Ponoi, and was again seen near the fjord of Kola. The same was the case with the Spruce, which appears to be *Pinus Abies* var. *medioxina* of Nylander, or *obovata* of Ruprecht. The typical form of *Pinus Abies* occurs between Kantalaks and Kuusamo. Along the coast *Betula tortuosa* grows, and in the interior of the peninsula, near Kola, *Betula alba*. Among species new to Eastern Lapland, the following are enumerated :—*Veronica officinalis*, *V. Chamœdrys*, *Littorella lacustris*, *Subularia aquatica*, *Brassica campestris*, *Raphanus Raphanistrum*, *Callitriche autumnalis*, and *Hippuris maritima*.

Among ferns collected we may notice—*Asplenium crenatum*, Fr. ; *Botrychium lanceolatum*, Rupr. ; *B. matricarioides*, Willd. No *Isoetes* nor *Chara* was found by the party in the peninsula of Lapland. In the lakes of Susijærvi and Ruanjærvi (lat. 67°) they found *Isoetes echinospora*, Dr. They noticed a singular deficiency in species of Lichens. One cause of this may be the absence of forests. Near Ponoi the following Lichens were gathered :—*Siphula ceratites*, Whlnb.; *Thamnolia vermicularis*, Ach. ; *Bœomyces placophyllus*, Ach. ; *Alectoria ochroleuca* and *A. nigricans*, Ach. ; *Nephroma expallidum*, Nyl. ; *Peltigera polydactyla*, Hoffm. ; *Sticta linita*, Ach. ; *Parmelia sulcata*, Tayl. ; *P. saxatilis*, *P. physodes*, and *P. prolixa*, Ach.; *Pannaria nigra*, *Squammaria gelida*, *Lecidea arctica*, Sommf.; *L. stenotera*, Nyl.

In speaking of the Russian Laps, called Murmanski, who live by fishing, M. Fellman states they use certain magical arts in order to take the fish and to render them more abundant. An element of great

importance in the magical proceedings is an earthy substance called *Rosli-ladan*, which is sold in the churches. A fisher always carries a certain quantity of this substance (however small) with him. The magical ceremony is performed by hollowing out a piece of wood in a cup-like manner, and putting in some bits of charcoal sprinkled over with the *Rosli-ladan*. They then pass the cup over the nets while the operator repeats some magical words in a low tone of voice, spitting energetically from time to time. The ceremony is finished by certain recommendations, after which the magician gives the assurance of plenty of fish. The invocation of the magician is addressed to St. Peter and St. Paul, who are requested to draw fish into the net of the person to whom it belongs.

M. Charles Martins has recently published an account of the Vegetation of Spitzbergen compared with that of the Alps and Pyrenees.*

Spitzbergen, situated between 76° 30′ and 80° 50′ of latitude, may be said to exhibit the extreme limit of our European Flora. It may be said to furnish a representation of the Glacial epoch which has preceded that in which we live. The climate of Spitzbergen is not so cold as that of the northern parts of America situated in the same latitude, such as the extremity of Baffin's Bay known by the name of Smith's Sound. This modification of the climate is due to the action of the Gulf stream.

The following are the mean monthly temperatures of Spitzbergen under latitude 78° :—

January	−18·2 Cent.	July	2·8 Cent.
February	−17·1	August	1·4
March	−15·6	September	− 2·5
April	− 9·9	October	− 8·5
May	− 5·3	November	−14·5
June	− 0·3	December	−15·0

The mean temperature of the year is −8·6 Cent. After entering fully into the details of climate and temperature M. Martins notices the physical and geological structure of the Islands, and then proceeds to consider the Flora. The vegetation is scanty. It occurs on the dark rocks on which the snow has melted. Lichens and Mosses are the first plants which appear. Among the latter may be mentioned Eremodon Wormskioldii, Brid.; Polytrichum alpinum, L.; and Bryum julaceum, Schr. At the foot of the rocks inhabited by sea-birds, whose guano fertilizes as well as warms the ground, we meet with species of Ranunculus, Cochlearia, and Grasses, along with Papaver nudicaule. Nowhere is a shrub or tree to be seen. The last of these, the Birch, the mountain Ash, and the Scotch Fir, are

* 'La Végétation du Spitzberg comparée à celle des Alpes et des Pyrénées.' Par Charles Martins, Professeur d'Histoire Naturelle de la Faculté de Médecine de Montpellier, 1865.

arrested in Norway under the 70th degree of latitude. There are, however, some ligneous plants, *viz.* two species of Willow (*Salix herbacea* and *S. retusa*), and *Empetrum nigrum.* The rest of the vegetation consists of low herbaceous plants. Many of them are so small as to have been passed over by travellers, and thus we find the list of the plants varying. In 1675 Frederick Martens, of Hamburg, describes and figures only 11 land species of plants. Phipps, in 1773, collected 12, which were named and described by Solander. Scoresby gathered 15, which were described in 1820 by Robert Brown. In 1822 Captain Sabine collected 24, which were determined by Hooker, who also made known the 40 species collected by Parry in 1827. Sommerfelt gave the names of 42 species gathered by Keilhau in 1827. In 1838 and 1839 Vahl, a Danish botanist, along with M. Charles Martins, collected at Bell Sound, Magdalena Bay, and Smeerenberg, 57 species. In 1858 Messrs. Torell, Nordenskiold, and Quennerstedt enriched the Flora by 6 species; and the Scientific Swedish Commission, in 1861, added 21. Malmgren, the botanist of the Expedition, made the total number of Spitzbergen flowering plants 93. M. Lindblom enumerated 152 Cryptogamous plants (Mosses and Lichens), thus making the entire Flora of the Islands 245.

The number of flowering plants is very small. Iceland, in lat. 65°, and with a much smaller surface, contains 402. Of the 93 Phanerogams of Spitzbergen 81 occur in Greenland; 58 in the islands which border the straits of Lancaster, Barrow, and Melville, near the 75th degree of N. L., and 53 on the peninsula of Taymir, in Asiatic Siberia. The crown of flowers which surrounds the north pole is not so varied as that of other regions of the globe. In these northern regions we find the same plants or species belonging to the same genera and the same orders. *Gramineæ*, *Cruciferæ*, *Caryophyllaceæ*, and *Saxifragaceæ* predominate, and amongst the genera we find *Draba*, *Saxifraga*, *Ranunculus*, *Carex*, and *Poa.* All the species are perennial. This seems to be a condition of their existence. Spitzbergen combines a Scandinavian and an Arctic Flora.

M. Martins contrasts the Spitzbergen and Lapland Flora with that of the Alps. On the summit of the Faulhorn he finds 8 Spitzbergen species, viz. *Ranunculus glacialis*, *Cardamine bellidifolia*, *Silene acaulis*, *Arenaria biflora*, *Dryas octopetala*, *Erigeron uniflorus*, *Saxifraga oppositifolia*, and *Polygonum viviparum*, and 40 of the Lapland plants. None of these plants belong to the Arctic Flora properly so called, but to the Scandinavian Flora.

Martins next contrasts the Spitzbergen Flora with that of the *Jardin* and of the Grand Mulets on Mont Blanc, with that near the Vincent Chalet on Monte Rosa, the culminating point of the Col Saint Theodule, and the summit of the Pic du Midi.

The paper contains full lists of the plants on these elevated localities, and exhibits in an interesting manner the relation which they bear to the Scandinavian and Arctic Floras.

Flowering Plants of Spitzbergen, as given by M. Charles Martins.

[The species printed in italics are found in Britain. Those marked with an asterisk (*) are exclusively Arctic, and do not exist in Scandinavia.]

Ranunculus glacialis, L.; R. hyperboreus, Rottb.; R. pygmæus, Wbg.; R. nivalis, L.; R. sulphureus, Sol.; *R. arcticus, Richards; Papaver mudicaule, L.; *Cardamine pratensis*, L.; C. bellidifolia, L.; Arabis alpina, L.; *Parrya arctica, R. Br.; Eutrema Edwardsii, R. Br.; *Braya purpurascens, R. Br.; Draba alpina L.; *D. glacialis, Adams; *D. pauciflora? R. Br.; *D. micropetala? Hook.; D. nivalis, Liljebl; *D. arctica, Fl. Dan.; *D. corymbosa, R. Br.; *D. rupestris*, R. Br.; D. hirta, L.; D. Wahlenbergii, Hartm.; Cochlearia fenestrata, R. Br.; *Silene acaulis*, L.; Wahlbergella (Lychnis) apetala, Fr.; W. affinis, Fr.; *Stellaria Edwardsii, R. Br.; *S. humifusa, Rottb.; *Cerastium alpinum*, L.; *Arenaria ciliata*, L.; *A. Rossii, R. Br.; A. biflora, L.; *Honkeneja peploides*, Ehrh.; *Alsine rubella*, Wbg.; *Sagina nivalis*, Fr.; *Dryas octopetala*, L.; *Potentilla pulchella, R. Br.; *P. maculata*, Pourr.; P. nivea, L.; *P. emarginata, Pursh.; Saxifraga hieraciifolia, Waldst. and Kit.; *S. nivalis*, L.; S. foliosa, R. Br.; *S. oppositifolia*, L.; *S. flagellaris, Sternb.; *S. Hirculus*, L.; *S. aizoides*, L.; *S. cernua*, L.; *S. rivularis*, L.; *S. cæspitosa*, L; *Chrysosplenium alternifolium* var. tetrandrum, Th. Fr.; Arnica alpina, Murray; Erigeron uniflorus, L.; Nardosmia (Tussilago) frigida, Cass.; *Taraxacum palustre*, Sm.; *T. phymatocarpum, Vahl.; *Mertensia* (Pulmonaria) *maritima*, L.; *Polemonium pulchellum, Ledeb.; Pedicularis hirsuta, L.; Andromeda tetragona, L.; *Empetrum nigrum*, L.; *Polygonum viviparum*, L.; *Oxyria reniformis*, Hook.; *Salix reticulata*, L.: S. polaris, Wbg.; *Juncus biglumis*, L.; Luzula hyperborea, R. Br.; L. arctica, Blytt; Eriophorum capitatum, Host.; *Carex pulla*, Good; C. misandra, R. Br.; C. glareosa, Wbg.; C. nardina, Fr.; *C. rupestris*, All.; *Alopecurus alpinus*, Sm.; *Aira alpina*, L.; Calamagrostis neglecta, Ehrh.; Trisetum subspicatum, P. Beauv.; *Hierochloe pauciflora, R. Br.; *Dupontia psilosantha, Rupr.; *D. Fischeri, R. Br.; *Poa pratensis*, var. alpigena, Fr.; P. cenisia, All.; P. stricta, Lindeb; *P. abbreviata, R. Br.; P. vahliana, Liebm.; *Glyceria angustata, Mgr.; Catabrosa algida, Fr.; *C. vilfoidea, Anders.; Festuca hirsuta, Fl. Dan.; *F. ovina*, L.; *F. brevifolia, R. Br. Thus of the 93 flowering plants of Spitzbergen, 69 species occur in Scandinavia, and 29 of them also in Britain, while 23 are exclusively Arctic.

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*Ferns of Southern India.**

We have received this work now completed in 20 fasciculi, which is very creditable to the author, one of the most ardent and promising botanists in British India, known by his contributions to the 'Madras

* 'The Ferns of Southern India, being Descriptions and Plates of the Ferns of the Madras Presidency.' By Captain Beddome, Officiating Conservator of Forests. 4to. Madras, 1864.

Journal of Science,' and the 'Linnean Society's Transactions.' There are 271 plates, executed by the same native artist who delineated a large portion of Wight's *Icones plantarum Indiæ Orientalis*, accompanied by a synopsis of the tribes and an analytical table of the genera with their synonyms. This work is an important addition to our literature, and must find a place in the library of every botanist who wishes to study the Flora of South India; the only previous notice of S. Indian Ferns being a memoir, *Filices Nilagiricæ*, by Gustave Kunze, in the 'Linnæa,' July, 1851.

We are glad to learn that Captain Beddome proposes to publish in six additional fasciculi the ferns peculiar to Northern India.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Several papers of much interest relating to the rarer metallic elements require a passing notice. The first we may mention is that by C. Winkler, on Indium. So far as we know, Winkler is the only chemist (other than the discoverers, MM. Reich and Richter) who has experimented upon indium; and it is satisfactory to find a substantial agreement in the descriptions of the metal and its compounds. It must be noted, however, that the last investigator deduces a lower atomic weight. The discoverers gave the number 37·07; but the determinations of Winkler lead to the number 35·918, a number which he states, however, as only to be accepted provisionally. Indium, our readers will remember, is found in zinc reduced from blende. The method given by Winkler for its separation is exceedingly simple. Zinc is boiled in dilute hydrochloric or sulphuric acid, until nearly all is dissolved. The black residue left will contain all the indium, together with some iron, arsenic, cadmium, and lead. This residue shows well the characteristic line in the spectrum; but to obtain indium perfectly pure a somewhat tedious process is necessary, which will be found described in the paper indicated below.

Troost has lately obtained Zirconium in the crystallized state, by heating the double fluoride of zirconium and potassium with aluminium. After a very strong heat, the temperature of melted iron, crystalline plates of zirconium, lying close together like the leaves of a book, are found upon the surface of the aluminium. Some zirconium, however, alloys itself with the aluminium; and at a lower temperature, that of melted silver, only an alloy of the two is obtained. Troost arranges zirconium in the carbon group, and places it between the metalloid silicium and the metal aluminium.*

Hiortdahl has communicated to the Academy of Sciences † some researches on zirconia, $Zr\ O_2$, made to ascertain its affinity for bases, and to show that it really plays the part of an acid. It was found that

* 'Comptes Rendus,' t. lxi. p. 109.
† 'Comptes Rendus,' t. lxi. pp. 175, 213.

zirconia is but a weak acid. It expels carbonic acid from carbonate of soda at a high temperature, and forms the compound Na O, Zr O_2, which is decomposed by water, zirconia being separated. At a higher temperature the compound 2 Na O, Zr O_2 is produced, and when this is treated with water a crystallized hydrate of zirconia separates. It is remarkable that when zircon, a native silicate of zirconia, or a corresponding mixture of silica and zirconia, is heated with carbonate of soda, only the zirconia enters into combination with the alkali.

Some compounds of Thorium, another rare metal, have been experimented upon by Delafontaine, Chydenius, and others, principally with the view of determining the atomic weight of the metal, which had been left uncertain by Berzelius.* Although not quite in accordance with one another, they agree in assigning a lower equivalent weight than that of Berzelius. This last authority gave 844·9 as the equivalent of thorina; but, according to Delafontaine and Chydenius, the number should be 823 (O = 100). Chydenius considers thorina as the analogue of zirconia and titanic acid, and has assigned to it the formula Th O_2; Hiortdahl, however, states, in one of the papers quoted above, that thorina will, under no circumstances, combine with bases.

The compounds of Niobium have been of late the subject of many researches by Deville, Marignac, and Blomstrand. The last-named author states,† as the results of his experiments, that only two metals constitute the niobium group—niobium and tantalum. Rose's pelopium has already been proved to be niobium, and Von Kobell's dianic acid, Blomstrand states, is niobic acid, pure, or perhaps mixed with a little tantalic acid. With regard to the atomic weight of niobium, which Rose was unable to fix with certainty, the writers named above differ widely. Deville‡ gives the number 47 or 48·3; but Blomstrand, while admitting that his experimental results are not concordant, states his belief that the true equivalent of niobium is 39.§

We read that a Swedish chemist has succeeded in discovering a cheap and easy method of reducing and casting tungsten. From what is known of the properties of this metal, it would hardly seem susceptible of useful application by itself; but, in the form of alloys, as in the case of tungsten-steel, it may be of great value.

An easily fusible alloy may have an interest and use to many of our readers, so we give the composition of the most easily fusible we have met with in our reading. Von Hauer‖ states that an alloy, having the formula Cd_4, Sn_5, Pb_5, Bi_5, is perfectly fluid at 65·5 C. The proportions for making this compound can be easily calculated from the equivalent weights of the metals.

Not many of our readers, probably, have seen *pure* iron, and they may perhaps be astonished to learn, upon the authority of Stahlschmidt,¶ that the metal which the author obtained by reducing the

* 'Bulletin de la Société Chimique de Paris,' April, 1865, p. 278.
† 'Comptes Rendus,' t. lxi. p. 337.
‡ 'Comptes Rendus,' June 12, 1865.
§ 'Annalen der Chem. und Pharm.,' Bd. lix. s. 198.
‖ 'Journal für prakt. Chem.,' Bd. 96, s. 436.
¶ 'Poggendorff's Annalen der Chem. und Physik,' No. 5, 1865.

nitride in a stream of hydrogen is of a silver-white colour, and so soft that it may be cut with an ordinary knife.

Before leaving the metals, we may mention a process for the preparation of potassium, which the author, Beketoff,* thinks may be applied to the commercial manufacture of the metal. He simply heats hydrate of potassium and aluminium in a gun barrel. The process is certainly extremely simple; but while aluminium is only to be obtained with the aid of sodium, it is not likely to be employed by a manufacturer.

Though scarcely belonging to Chemistry, we may place on record here Mr. Gale's process for rendering gunpowder non-explosive for storage and transport. The inventor simply mixes three or four parts of finely-powdered glass with one part of the powder, and when the latter is required for use the two are separated by means of a sieve.

Some very useful papers on analytical chemistry have been published since our last. The first we may notice has reference to the analysis of waters,† and gives a method of arriving at the true composition of the saline matters. The author first treats the dry residue several times with boiling absolute alcohol, by which he separates the chlorides. The residue is boiled in water, and this solution gives the soluble sulphates. The residue, insoluble in water, may still contain sulphate of lime, the amount of which may be calculated from the sulphuric acid, while the excess of lime, magnesia, and iron found in a hydrochloric solution, may be calculated as carbonates.

A residue insoluble in water and acids is sometimes also very difficult of fusion, and chemists will thank Professor Bloxam for a simple method‡ of fluxing small quantities, which will save analysts much trouble. The author prepares a mixture of one part of fine charcoal and six parts of nitre. Five grains of the insoluble residue to be examined, and ten grains of carbonate of soda, are mixed with seventy grains of the deflagrating mixture, and a match is applied. Deflagration and consequent fusion immediately take place. The operation may be performed in a thin porcelain dish, or even on an iron tray, for the metal will not be affected. It is sufficient to say that the process answers with such refractory substances as quartz sand, pipe-clay, and fluor spar. Chrome iron ore alone withstands the treatment.

In estimating alkalies it is necessary to convert nitrates into chlorides. This is done by evaporating the nitrate with an excess of hydrochloric acid. Dr. Leucanus§ finds that it requires the repetition of the evaporation with acid several times to convert the greater part of the nitrate into chloride. A small proportion of nitrate, indeed, remains undecomposed after twelve evaporations. The author therefore suggests igniting the nitrate with grape sugar to convert it into carbonate, and extracting the alkali from the carbonaceous residue with hydrochloric acid.

* 'Zeitschrift für Chem. und Pharm.' New Series. Bd. 1, s. 376.
† 'Chemical News,' vol. xii. p. 87.
‡ 'Journal of the Chemical Society,' August, 1865.
§ 'Zeitschrift für Analyt. Chem.,' Bd. iii. s. 403.

Fresenius has made a series of experiments on the determination of phosphoric acid as phosphomolybdate of ammonia.* He finds, in effect, that the results are sufficiently correct in a nitric acid solution; but hydrochloric acid, even when very dilute, somewhat interferes with the precipitation.

We may here notice very shortly a method of elementary organic analysis, proposed by Dr. Ladenburg,† to supersede in some cases Liebig's combustion process. The author encloses a weighed amount of the substance to be analyzed in a small glass bulb, which he places in a stout tube containing a weighed quantity of iodate of silver and some monohydrated sulphuric acid. This tube being sealed, the bulb is broken by agitation and the tube heated, whereupon the organic substance is oxidized at the expense of the oxygen of the iodic acid. At the end of the operation the tube is weighed; it is then opened, and the carbonic acid pumped out; the loss of weight gives the amount of the acid formed. The free iodine is then estimated in the sulphuric acid solution by Bunsen's method; and thus the amount of oxygen required for the oxidation is ascertained. This method, it will be seen, is specially applicable for the volatile hydro-carbons.

Mr. Ullgren has contributed to the 'Journal of the Chemical Society'‡ a method of estimating very closely the amount of blue colouring matter in indigo. It is a volumetric method based on the fact that ferricyanide of potassium in the presence of a free alkali, destroys the indigotin and produces colourless isatin. The solution of ferricyanide he employs contains 2·5115 grammes of the salt in a litre, consequently 2 c.c. change 1 milligramme of indigotin into isatin. To ensure accuracy in the determination, the quantity of sulphuric acid added to the indigo solution should not be too great, and the temperature should not exceed 50°; the indigo solution must be very dilute; and the solution must be made strongly alkaline by carbonate of soda. The operation may be regarded as complete when the bluish-green solution assumes a grey-yellow appearance; or when every tint of blue has disappeared.

As a ready means of distinguishing between bismuth and lead, we may give a test described by Nicklés, who shows that the chlorothallate of ammonia precipitates bismuth, but does not precipitate lead.

In connection with organic chemistry, we notice the researches of M. Fremy on the green colouring matter of leaves.§ The author shows that chlorophyll yields two distinct colouring matters which may not, however, primarily exist in that body. When an alcoholic solution of chlorophyll is boiled with hydrate of baryta, a yellow body, phylloxanthine, is precipitated along with a barytic salt of phyllocyanic acid. The former may be dissolved out by alcohol, and obtained in reddish-yellow crystals by evaporating the solution. The barytic salt mentioned when decomposed by sulphuric acid, gives a solution

* 'Zeitschrift für Analyt. Chem.,' Bd. iii., p. 446.
† 'Annalen der Chem. und Pharm.,' Bd. lix. s. 1.
‡ August, 1865. § Comptes Rendus, t. lxi. p. 188.

of phyllocyanic acid which is green, or reddish-violet, or blue according to the strength of the solution. M. Fremy thinks it possible that chlorophyll may be a sort of soap, in which phylloxanthine plays the part of glycerine, and phyllocyanic the part of the fatty acid.

The oxidation of fatty matters has for a long time engaged the attention of M. Cloéz, who has recently published the results of his investigations.* The author shows that it is not a simple oxidation attended with the production of carbonic acid, when an oil is exposed to atmospheric air. Other compounds with hydrogen he states are formed, among which he has recognized acrylic and acetic acids. Other volatile compounds he thinks are also formed. Oils exposed in coloured glasses he finds, after a time, to oxidize faster than those exposed to white light: heat likewise greatly accelerates the oxidation.

Very little in the technical applications of chemistry calls for notice this quarter. M. Pasteur has tried the effect of artificially applied heat in ripening wines, and preventing what is called sickness in them. He shows that a short exposure to 60° or 70° is sufficient to destroy the parasitic germs, which he believes to be the cause of the sickening, while the increased temperature accelerates oxidation, and produces the compounds which give the flavour of age to the wine.

A. M. Pienowski has suggested the employment of acetate of soda in place of common salt for preserving meat. He states that the former salt is more easily removed from the meat, while the flavour communicated is preferable.

We may give here two processes proposed for obtaining oxygen at a cheap rate. M. Carlevaris suggests heating binoxide of manganese with fine sand, thus producing silicate of manganese and setting free one equivalent of oxygen. M. Archereau proposes to heat silica with sulphate of lime and so produce silicate of lime and set free a mixture of sulphurous acid and oxygen. The former gas he removes by passing the mixture through water.

Proceedings of the Chemical Society.

But one meeting of the Chemical Society has been held since our last report. At this meeting Dr. Frankland gave a verbal account of experiments by himself and Mr. Duppa on the transformation of the lactic into the acrylic series of acids; and Mr. W. H. Perkin read a paper on the action of nascent hydrogen on Azodinaphthyldiamine. The titles of some other communications were read, which we find at length in the Journal of the Society, and may here refer to. Professor Church described a new Cornish mineral of the Atacamite group, and also a specimen of limonite from Cornwall. The description of these will be more properly included in our mineralogical report.

Mr. R. Warington, junior, made a communication on the occurrence of manganese in oolite and lias, and showed the presence of the

* 'Comptes Rendus,' t. lxi. pp. 236, 321.

metal in the leaves and trunks of trees growing on the soil. It is pointed out that the amount of manganese in the lias is considerably above that in the oolite.

Professor Church also publishes some analyses of bronzes found in Great Britain, which show that much of the so-called bronze of the Roman period should be called brass, being composed principally of copper and zinc. A specimen of Celtic bronze, analyzed by Mr. Church, was mainly composed of copper, tin, and lead, while another was principally copper and zinc.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

In June, 1861, Professor N. Wagner, of Kasan, accidently found what he calls "the spontaneously multiplying larvæ of," to him, an "unknown member of the Diptera."* These larvæ were filled with other larvæ exactly like them. At first he thought it was a case of parasitism, but after examining many of them, he became convinced that the secondary larvæ had been developed from "embryonal bodies" indisputably belonging to the organism of the parent larvæ. This discovery does not appear to have excited much attention; an American author, however, considers the statement to be "a pure and simple delusion." In a recent number of Siebold and Kölliker's Zeitschrift für Zoologie (1865, p. 106) Professor Wagner enters into a long and elaborate account of his observations. He says that "in carefully watching the larvæ every day one sees clearly that new larvæ crawl out of them, and, like them, in from seven to ten days bring forth other new larvæ." Some of these he kept by him during the winter, and the larvæ multiplied in this way all the time. The pupa state was assumed from the 6th to the 8th of June, and three or four days after the insects came forth. The "embryonal bodies" differ from eggs, in that they arise from alterations in the organism, while eggs are developed in special sexual organs. In the first case, impregnation is never necessary, and to this category of organic generations Professor Wagner would confine the term "Parthenogenesis." More recently Professor von Siebold, having had some of the larvæ sent to him, is satisfied that the young larvæ are really produced by the mother larvæ, and therefore "that all thoughts of their being parasites must be given up."

The conclusions of Mr. Walsh respecting dimorphism in the Gall-flies † appear to have met with less acceptance in Germany than in this country. M. Reinhard, of Bautzen,‡ considers that

* It is the *Miastor metraloas* of Meinert, and belongs to the sub-family Cecidomyinæ. A well-known species in this group is the wheat-fly (*Cecidomyia tritici*).

† 'Proc. Entom. Soc. of Philadelphia,' March, 1864.

‡ 'Be liner Entom. Zeitschrift,' 1855, p. 1 et seq.

Walsh's hypothesis rests entirely on the identity of the galls,* and that the characters he gives of *Cynips spongifica* produced from the summer gall, and of *Cynips aciculata* from the winter gall, require, from morphological considerations, that they should be generically separated. The transition forms which Mr. Walsh finds between the two galls signify nothing. Galls of various species of cynips often appear to be transitional between other forms, and are only known with certainty when the insect appears. Thus Reinhard says that the galls of *C. lignicola* are scarcely to be distinguished from those of *C. conglomerata*, or the latter from those of *C. Kollari*, although all three galls when fully and normally formed appear very different. So with the galls formed on oak-leaves by our European species, as those of *C. folii*, *C. scutellaris*, *C. longiventris*, *C. agama*, *C. divisa*, and *C. disticha*, which resemble each other so much, that it is not to be wondered at if some examples appear to form a transition from one species to another. In further confirmation of the deceptive resemblances between galls of widely different species, compare those of *Lasioptera rubi* with those of *Diastrophus rubi*, or of *Cecidomyia circinans*† with those of *Neuroterus lanuginosus*. Mr. Walsh appears to have erred in the belief that it is only males which are hatched from unfertilized eggs, for, according to Dr. von Siebold, in the *Psychidœ*, the unfertilized eggs give only females.

Still the facts brought forward by Walsh to bear on his hypothesis are so remarkable, that it is necessary to seek other explanations. Reinhard suggests that *C. spongifica* may either be an inquiline of *C. aciculata*, or that *C. spongifica* and *C. aciculata* may be generically distinct species, only making similar galls. If *C. spongifica* be an inquiline, then it will form an exception to the rule that inquilines always appear either at the same time or *after* the gall-maker ; further, *C. spongifica* had an inquiline of its own (*Synophrus læviventris*, Ost. Sack.), while with *C. aciculata* nothing else appeared.

So far as negative evidence *can* go, the male sex of many genera of Cynipidæ has no existence, so that reproduction is exclusively confined to the females. Unwilling to adopt this conclusion, it has been attempted to show that the males may be among the inquilines. Reinhard, however, objects to this : he thinks that if there were really dimorphism in the females, so that both the inquiline female and the maker of the gall were served by the male inquiline of the former, that only the same species of inquiline would be found in the same gall. This is by no means the case, as Hartig has bred from Cynips folii, *Synergus nigripes*, *S. flavicornis*, &c., and from Biorhiza renum, *Synergus tibialis*, *S. luteus*, &c. Furthermore, inquilines ought only to occur in the agamic genera, whereas, on the contrary, they are found in the galls of such bisexual groups as *Andricus*, *Teras*, and others. All the genera appearing in summer are two-sexed, the flies taking a short

* Mr. Wilson Armistead, of Virginia House, Leeds, who "has been an observer of galls and similar excrescences for twenty years or more," is "preparing a volume to contain the result of these observations." He makes an earnest appeal to all naturalists for information and any particulars respecting them.

† *Lasioptera* and *Cecidomyia* belong to the Diptera.

time to develope, as they come out in the same summer in which the gall first appears. The agamic series appears in the winter, that is, from October to December. A third series, including the genera *Aulax*, *Diastrophus*, and *Rhodites*, is delayed to the second summer; of these the males are much rarer than the females.

Dr. A. Laboulbène * has given a long account of the musical organs of a moth (*Chelonia pudica*). These were discovered more than thirty years ago by M. Villars, but the subject has not excited much attention. They exist in both sexes, but are larger in the males, and consist of a hollow triangular cavity, covered by a thin dry membrane, placed on each side of the thorax, close to the insertion of the inferior wings. The sounds, which the writer compares to that of a stocking-maker's machine, are, he considers, caused by little taps given by the legs on the membrane, or by rapid lateral motion of the knees. Many species of the genus *Setina* are also furnished with similar organs, but their size varies in the females, some having them nearly as large as in the males, while in others they are scarcely distinguishable. There are somewhat analogous organs found in other members of the family Lithosiidæ, to which these two genera belong, but they are generally covered with scales, and are not calculated to produce sounds. In one species—*Pericopis Isse*—they attain to the highest degree of development, while in a very nearly allied form they do not exist.

A new position for a sound-producing apparatus has just been brought under the notice of the Entomological Society by Mr. Pascoe. The insect in which it occurs is a species of the lamellicorn genus *Bolboceras*, from Australia. The upper portion of its posterior coxa has certain grooved lines which correspond to another series of grooved lines in the cotyloid cavity, and the friction of one against the other causes a grating sound, just as a similar structure of the portion of the mesothorax lying under the prothorax produces the sounds so well known in many longicorn beetles, and which has earned for the Prionus coriarius in some parts of Germany the name of the "fiddler."

At a meeting of the Entomological Society in the spring, the Rev. Hamlet Clark, citing a passage from 'Cameron's Travels' in Malayan India, in which a statement was made that fire-flies (*Lampyridæ*) appeared to have a habit of exhibiting and extinguishing their light contemporaneously, remarked that he had observed a similar habit in the fire-flies of Brazil. This assertion appears to have occasioned some surprise: Mr. Bates, who had himself found some eighty or ninety species in the Amazons region, thought, on the contrary, that there was no concert between the different individuals, and that the contemporaneous flashing was an illusion produced probably by the swarms of the insects flying amongst foliage, and being continually, but only momentarily, hidden behind the leaves. Mr. W. Wilson Saunders in India, and M. Sallé in Mexico, had also never remarked any intermittency in the light. At the July meeting, however, Mr. Clark read an extract of a letter from Mr. Fry, a gentleman who had resided many years in Brazil, and who is well known to many

* 'Ann. Soc. Entom. de France,' t. iv. p. 689 et seq., 4me sér.

members of the Society as one of our foremost entomologists, corroborating the accuracy of his statement. Mr. Fry writes, "I can confirm your observations that the fire-flies of the genus *Aspisoma* flit at night in great numbers over low-lying damp fields, chiefly near water, emitting light at short intervals of three or four seconds, the majority keeping time with each other, as if in obedience to the baton of a leader. I think it is only the fire-flies of that genus who practise it. The numerous fire-flies common in Mexico and North America belong chiefly to the genera *Ellychnia* and *Photuris*, whose habits are different, so far as I have had an opportunity to observe their congeners in Brazil." 'The Reader' (April 1, 1865) observes, "Here is a new insect-wonder, before which the economy of bees and ants will sink into insignificance." Another moot-point, which has lately occasioned the revival of an old controversy, respects the luminosity of the lantern-fly * (*Fulgora laternaria*). The general opinion of the leading entomologists, including those who have seen them in their native haunts, is that they are not luminous; but a letter was read from an inhabitant of Belize, in which it was stated that the writer had kept one "a day" and that it was "decidedly luminous." It is not by off-hand statements that such problems are to be decided, though there seems to be no impossible reason why what has been asserted by so many should not be to a certain extent true.

Athough Bibliography scarcely enters into these Reports, it would be an omission not to mention such a work as has been just published by the Ray Society. It is on the 'British Hemiptera-Heteroptera,' by Messrs. Douglas and Scott, and forms a thick handsome octavo volume, with twenty-one exquisite plates by Mr. Robinson. Many of the non-entomological members of that Society will be astonished to find what numbers of strange and beautifully-coloured forms are living around them, belonging to a group of which the only member they know is the disgusting bed-bug. So far as we can judge—for the work has only been in our possession a few hours—the authors have executed their task most carefully and conscientiously, but it is to be regretted that they had not adopted a less ramified and complicated system than that of Dr. Fieber. Besides the divisions, sub-divisions, and sections, some of them with very uncouth and not very classical names, we find that the land-species alone described in this volume are distributed into not less than fifty-four families.

Entomological Society.

At the June meeting of this Society, letters were read from Mr. Edwin Reed, who has recently gone to Bahia with the intention of collecting in that, entomologically, little known locality, and from Mr.

* The lantern-flies do not belong to the Phasmidæ, as a writer in the 'Natural History Review' (1865, p. 19) has stated, but to the Fulgoridæ. The two families do not even belong to the same order. Is this the writer who thinks that "*ex-professo* entomologists should blush" (*id.*, p. 198) because Mr. Lubbock accidently found an aquatic Hymenopteron in a basin of pond-water?

Brewer, who had proceeded to the Azores with the same object. To all who take an interest in the geographical distribution of animals, the result of an investigation of the insect fauna of those islands will be looked forward to with great interest. Among the insects exhibited was a specimen of *Apate capucina*, Linn., a handsome boring beetle, captured in Bishop's Wood by Mr. Edgar Smith, which, although once taken by Sir Thomas Pasley, but under rather suspicious circumstances, in Pembroke dockyard, and by the Rev. F. W. Hope, has not been admitted into the British list. Mr. F. Moore read a paper on the genus *Saturnia*, with descriptions of new species.

July.—The Rev. Hamlet Clark read a letter from Mr. Fry respecting the simultaneous flashing of the light of the fire-flies (*Lampyridæ*). A letter was also read from the Rev. Douglas Timmins, giving an account of the winter entomology of Cannes (Dep. Var.). Dr. Armitage exhibited the cocoon of a female *Œceticus* from Monte Video, to which three males had resorted at the same time, and had been killed while their abdomens were still in the cocoon. Mr. Bates read a letter from Mr. Walsh, of Illinois, giving an account of the habits, and particularly of the hybernation, of the American species of *Limenitis*.

August.—Mr. W. Wilson Saunders brought for exhibition a large grasshopper (*Steirodon?*), which, with others in a young state, had been imported in a case of orchids, and having made their escape had done great injury in one of Mr. Saunders's hothouses. What was remarkable, they fed only during the night, and when not feeding appeared to be constantly engaged in cleaning their legs and antennæ, by drawing them through the mouth. Although Mr. Bates remarked that he had not met with any of nocturnal habits in South America, it is known that our *Acrida viridissima* is frequently found feeding at night. A *Cryptocephalus* (*C. decem-punctatus*), recently taken at Rannoch, and new to the British list, was exhibited by Mr. Sharpe. A collection of insects of all orders, made by Mr. Bouchard, at Santa Martha, was also laid before the meeting. Lieutenant Beavan sent from India some very beautiful drawings of the Tusseh silk-worm. A letter was read from Mr. S. Stone respecting the extraordinary abundance of female wasps last April, notwithstanding it appeared from the observations of many members that none were now to be found. No adequate explanation was given. A paper was read from Mr. C. A. Wilson, of Adelaide, on the Buprestidæ of South Australia. Mr. Baly also read a paper on the Phytophaga.

VI. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Geology is now so comprehensive a science, the number of labourers in its many fields has become so great, their discoveries are so numerous, and the advance of the science is so rapid, that in the few pages devoted to this Chronicle we can only pretend to give outlines of some of the most important subjects occupying the attention of geologists, together with notices of a few of the best investigations into the structure of our own islands. Frequently we are obliged to omit all mention of valuable results arrived at, both at home and abroad; and our endeavour has generally been to give as complete notices as possible of a few of the most instructive and successful researches that have recently been carried out, rather than short accounts of everything that has been published during each quarter, as in the latter case our Chronicles would have been little better than booksellers' catalogues. We have also endeavoured to select our subjects so as to show that important advances are continually being made in our knowledge of the structure of the earth, and of the forces which have modified its surface in past times; and it is with this view that we have sometimes given great prominence to apparently "out of the way" researches.

Within the last two or three years much attention has been given to the Physical Geography and Geology of the Sahara; and attempts have several times been made to explain important phenomena by means of the ancient condition of that vast and sterile area. The last two numbers of this Journal have contained communications relating to one supposed effect of the Sahara on the Meteorology of the globe, and our readers will therefore feel some little interest in the other phenomena which have been thought to have more or less connection with either its past or present condition.

The present characters of the Sahara are too well known to need description at our hands; but, considering them geologically, the question inevitably arises, When did the Sahara first assume these features? It appears that the great geographer Ritter, nearly half a century ago, suggested "that the African desert had been under water at a very modern period;"* and in 1852, M. Escher von der Linth gave it as his opinion, "that if this submergence were true, it would explain why the Alpine glaciers had attained in the Post-pliocene period those colossal dimensions which Venetz and Charpentier, reasoning on geological data, first assigned to them."† The subsequent discovery of the common existing cockle and other marine shells in the heart of the desert, and at various depths beneath the surface, left no doubt as to the submergence; and, granting this, M. Escher's conclusion seems reasonable enough, for everybody knows how the sirocco (called Föhn in Switzerland) sometimes nearly strips the Alps of their snowy covering. Sir Charles Lyell has also remarked, that during the submergence of the Sahara the sirocco would not only be deprived

* Lyell's 'Elements,' sixth edition, p. 175. † Op. et loc. cit.

of its heat, but would also become charged with moisture, which being deposited on the mountains in the form of snow, would *add* to the volume of their glaciers; that is to say, the glaciers would be larger, positively by the sirocco bringing material that it does not bring now, and negatively by its not melting the snow and ice, which it does now to a considerable extent. It therefore appears that the Sahara is very intimately connected with the present moderate climate of Europe.

Another phenomenon is the one which has been discussed in this Journal, namely, What influence has the Sahara on the north-east trade-wind? The cause of this wind has generally been stated to be a rush of cold air from the north, the direction of which is modified by the rotation of the earth on its axis. The existence of a south-east trade-wind on the other side of the equator is a strong argument in favour of this explanation, and against the view that the sister wind is due to a local cause; but that the Sahara may modify the force and direction of the north-east trade does not appear improbable.

The Sahara was submerged, then, during the Glacial Period; but what was its condition previously? This is the question that has chiefly induced us to notice the phenomena connected with the great African desert in this Chronicle, as the answer to it is of great importance to those who take an interest in Tertiary geology, and has only just been published.

The artesian wells sunk by the French have proved the existence of underground sheets of water at depths ranging to as much as 500 feet, and it is in boring them that so many facts bearing on the History of the Sahara have been discovered. M. Ville has written several memoirs descriptive of different portions of the desert, and his last production, entitled "Notes d'un Voyage d'Exploration dans les Bassins du Hodna et du Sahara," and published simultaneously in the last number of the 'Annales des Mines,'* and in the 'Bulletin de la Société Géologique de France,'† is remarkably important and contains a host of most interesting facts bearing on the distribution of these underground sheets of water. The point to which we now wish to draw attention is this: M. Ville shows that the surface in one part of the desert is formed of a Quaternary formation (Post-pliocene), to which he gives the name "Terrain Saharien," and nearer the mountains of an *underlying series of deposits of Pliocene age*, containing in some places marine fossils, namely, *Leda subnicobarica*, *Pinna cristellaria*, *Cassis*, *Tornatella*, &c. So far as we know, this fact is quite new, at least to geologists in England, and we await with much curiosity and impatience the publication of complete lists of the fossils, for it is more than probable that the Miocene fauna of the south of Europe, Madeira, &c., may have journeyed eastwards through the ancient desert-sea, and if this has been the case we may expect to find some traces of their passage in these Pliocene deposits of the Sahara. That the beds in question are really Pliocene appears certain, as their age is given on the authority of M. Deshayes.

* 6^me^ série, vol. vii., 2^me^ livr., pp. 117–156. † 2^me^ série, vol. xxii.

Dr. Waagen has just published a short but very able brochure entitled, 'Versuch einer allgemeinen Classification der Schichten des oberen Jura,' which reveals a very curious state of confusion in the minds of geologists and palæontologists as to the meaning and correlation of the "Coral Rag" of England and the "Corallien" of the Continent. The author took advantage of a visit to England to make a detailed examination of the Upper Oolitic strata of our south coast, in the neighbourhood of Weymouth; and a comparison of their fossils with those of their continental equivalents has resulted in his conviction of there being a strange delusion respecting the "Corallien" prevailing amongst geologists.

Our classification of these beds is, in descending order:—(1) Purbeck beds, (2) Portland rock, (3) Portland sand, (4) Kimmeridge Clay, (5) Upper Calcareous Grit, (6) Coral Rag or Oxford Oolite, (7) Lower Calcareous Grit, (8) Oxford Clay, (9) Kelloway rock. Dr. Waagen omits the Purbeck beds, and discusses the six succeeding subdivisions, comparing them with their continental equivalents, according to the following classification:—

	English Formations.	*Continental Equivalents.*
Kimmeridge Group.	1. Portland Stone. 2. Portland Sand.	Zone of *Trigonia gibbosa.*
	3. Kimmeridge Clay.	Solenhofen Platten-Kalk, or zone of *Orbicula latissima* and *Acanthoteuthis speciosa.* Zone of *Pterocera Oceani* and *Ammonites mutabilis.* Astarte-limestone and Zone of *Ammonites tenuilobatus.*
Oxford Group.	4. Upper Calcareous Grit. 5. Oxford Oolite	Zone of *Cidaris florigemma* and *Ammonites bimammatus.*
	6. Lower Calcareous Grit.	Zone of *Ammonites transversarius* and *A. Martelli.*

Now the remarkable point is that, according to Dr. Waagen, the "Corallien" of Cirin is on the horizon of the Portland beds, that of Franconia corresponds with the upper division of the Kimmeridge Clay, that of Nattheim (Swabia) with the middle, and that of La Rochelle with the lower; our own Coral Rag and the "Corallien" of the Swiss geologists belong to the next group, and the "Corallien" of Thurmann and Etallon is the equivalent of the Lower Calcareous Grit. Our author characterizes this state of affairs as a "schöne Verwirrung," an expression which we may take to signify a "magnificent muddle!"

Professor M'Coy has contributed a very interesting paper to the August number of the 'Annals and Magazine of Natural History,' entitled "On the Occurrence of *Limopsis Belcheri*, *Corbula sulcata*, and some other recent Shells in the fossil state in Miocene Tertiary Beds, near Melbourne." The first-named species lives at the present day off the Cape of Good Hope, and the few known specimens of it were brought up alive from a prodigious depth by Admiral Belcher. A second species of *Limopsis* (*L. aurita*), which has been dredged by

Mr. Gwyn Jeffreys, off Unst, in Shetland, from a depth of 85 fathoms, and occurs fossil in our Coralline Crag and in the Miocene beds of Germany, is also common in the Australian deposits. The *Corbula sulcata* now lives on the west coast of Africa; with it and the foregoing species occur the recent *Pectunculus laticostatus* of New Zealand, and the Eocene *Dentalium Mississippiense* of Vicksburg. If the remaining species have similar extraordinary ranges, it will be rather difficult to determine how they became associated in the Miocene Australian sea.

Of recent local memoirs, we have a large number before us, all deserving of notice; but we must content ourselves with glancing at the following:—Mr. Boult's paper "On the alleged Submarine Forests on the Shores of Liverpool Bay and the River Mersey," reprinted from the Journal of the Polytechnic Society, is an attempt to show that the three beds of peat occurring at Dove Point, &c., are not the remains of so many submerged forests, but are the results of the bursting of peat-mosses, similar to that of Chat Moss, described by Leland as having occurred in the beginning of the sixteenth century. The author considers also that these forest-beds and the intercalated silts are not sufficient evidence of a depression and subsequent re-elevation of the country. His arguments are ingenious, but rather dogmatically expressed; they do not carry conviction to our mind, and we cannot think that his view is the right one; but his paper is well worth reading, as it forces one's train of thought off the rails on which it usually runs, and happily the inevitable collision with the author's ideas does us no bodily harm.

Mr. Hull's paper on the Drift-deposits, &c., in the neighbourhood of Manchester, has some connection with the one just noticed, as it contains a sketch of some very recent gravel and sand beds at Heaton Mersey, containing an interstratified bed of peat which may represent an old land-surface, but may be due to a former extension of the river. The chief object of the paper is, however, to extend, and in some measure to correct, Mr. Binney's previous observations and classification of the drift-beds of this district. The two classifications are as follow:—

	Binney.	Hull.
Recent . . .	1. Valley-gravel and River-terraces.	1. Valley-gravel and River-terraces.
Post-pliocene or Drift .		2. Upper Boulder-clay.
	2. Forest sand and gravel.	3. Middle Sand and gravel.
	3. Till or Boulder-clay.	4. Lower Boulder-clay or Till.
	4. Sand and Gravel, more inconstant and less important than No. 2.	

The last of these papers that we have room to notice is Professor Buckman's Essay "On the Geology of Gloucestershire in reference to Agriculture and Rural Economy," reprinted from the Bath and West of England Agricultural Journal. To the farmers of Gloucestershire it must be a welcome little guide, and we should be glad to hear that its author had expanded it into a more exhaustive text-book. Professor

Buckman treats of the subsoils in relation to water-supply, their adaptation to particular crops, the flora of the district, and other subjects; he also gives analyses of different rocks, and tables showing their relative yield of several crops and their comparative value per acre. A complete series of such memoirs would form a valuable 'Manual of the Agricultural Geology of Great Britain.'

'The Geological Magazine' has lately been remarkably good, and the Original Articles have been more generally interesting than before; three of the most recent papers are brief geological guides to the districts of which they treat, and have doubtless been useful to geological tourists during the past summer: these are, Mr. Mackintosh's "Notes on the Surface-geology of the Lake-district," Mr. Peach's paper "On Traces of Glacial Drift in the Shetlands," and Mr. Davies's account of "A Walk over the Ashbeds and Bala Limestone near Oswestry." Professor Owen's paper on *Miolophus*, a new genus of Mammal allied to *Hyracotherium*, from the London clay of Sheppey, has, of course, a more lasting value. Professor Phillips's note on Oxford fossils is interesting, and Mr. Guppy's paper on the Tertiary deposits of Trinidad is unusually so, as the author infers that a much colder climate prevailed in that region during or near the time of our Glacial Period.

With great sorrow we are again obliged to record the death of an eminent palæontologist. Dr. S. P. Woodward, author of the well-known 'Manual of Recent and Fossil Shells,' and of many original memoirs on conchological and geological subjects, expired at Herne Bay on July 11, at the early age of 43. We must refer our readers to the August number of the 'Geological Magazine' for an obituary notice of this talented naturalist, from whose loss palæontology in England must long suffer.

Proceedings of the Geological Society.

The August number of the 'Quarterly Journal' includes a much larger share of the Society's Proceedings than its predecessor. Of the eleven papers contained in it, four treat of the Post-tertiary deposits of Scotland, namely:—

Mr. T. F. Jamieson "On the History of the last Geological Changes in Scotland."

Dr. J. Bryce "On the Order of Succession in the Drift-beds of the Island of Arran."

Dr. J. Bryce "On the Occurrence of Beds in the West of Scotland beneath the Boulder-clay."

Rev. H. W. Crosskey "On the *Tellina calcarea* Bed at Chappel Hall, near Airdrie."

Mr. Jamieson's paper is remarkable as a compilation, and inherently valuable from its containing a large number of new facts, and a classification of them and of those previously known. The author distinguishes in the Post-tertiary beds of Scotland the re-

presentatives of no less than six different periods, one of which is Pre-glacial, three are Glacial, and two Post-glacial.

Of the Pre-glacial period there are traces only. The first of the Glacial periods is that of "Land-ice," during which the rocky surface of the country was scratched and polished, and the Boulder-earth was accumulated; the second is the "Period of Depression," during which the Glacial-marine beds, containing Arctic shells, and the stratified beds occurring at high levels were deposited; the third is that occupied by the "Emergence of the Land," during which the glaciers finally retreated, and the Valley-gravels, Moraines, and Submarine Forest-beds were deposited. The close of this period is properly Post-glacial, and Mr. Jamieson considers the submarine forest-beds to fall into this latter category.

The first of the true Post-glacial periods is termed by the author the "Second Period of Depression," and within its limits the Estuarine beds and raised beaches of Scotland were deposited; the former are of very great extent, and constitute the well-known Carse-lands of the Forth and Tay (including the Carse of Gowrie—the Garden of Scotland); in them, also, the first traces of man in Scotland have been discovered. The second and last period is that during which the land was elevated to its present position, and the blown sand, beds of peat, and shell-mounds were accumulated.

Concerning the date of this last change, Mr. Jamieson has nothing new to say, which is a very great pity, as the question is now in anything but a satisfactory condition; he states, however, that artificially chipped flints occur on the surface of some of the mounds, the bases of which are not more than four feet above the sea-level, and strewed on the rolled pebbles of the beaches of the last period, and it seems to us that this evidence is rather against Mr. Geikie's inference that the last elevation of Scotland was posterior to the Roman invasion; but Mr. Jamieson is inclined to be of a different opinion.

In an Appendix the author gives classified lists of the shells found in the different localites and deposits, with their present distribution; these lists and the paper altogether are indispensable to every student of Post-tertiary Geology, whether of Scotland or any other country.

Dr. Bryce's paper "On the Drift-beds of Arran" is a correction of the Rev. R. B. Watson's statement, that the Arctic shells discovered by him occurred in the Boulder-clay. Dr. Bryce, like other geologists of the West of Scotland, is of opinion that the Boulder-clay proper has not hitherto furnished any fossils; and he examined these Arran Drifts for the purpose of ascertaining whether Dr. Watson's shells really occurred in the Boulder-clay, or on the horizon in which they have been found in Clydesdale, namely, immediately above that deposit. As the result of his researches, Dr. Bryce states that the Arran shells occur in a bed of clay, immediately above the Boulder-clay, and beneath another series of beds, without fossils, which he terms "Upper Drifts." In Clydesdale a bed of laminated clay divides the Shell-bed from the Boulder-clay, the shells are better preserved than in Arran, and shells of British species occur in the "Upper

Drifts;" but in other respects the author draws a parallel between the two series. Dr. Bryce attributes to the Boulder-clay a glacial origin on land, and he ingeniously accounts for the differences in the Arran and Clydesdale series according to his theory of the formation and origin of their remaining members.

The next paper, also by Dr. Bryce, "On Beds in the West of Scotland beneath the Boulder-clay," is the result of an examination into the question whether the Elephant-remains which have been found near Kilmaurs really occurred in the Boulder-clay, or in beds beneath it, and he again succeeds in convincing himself that the Boulder-clay contains no fossils. In all probability Dr. Bryce is right, and the beds in which these Elephant-remains were found, and which occur beneath the Boulder-clay, no doubt come into the Pre-glacial period of Mr. Jamieson, who, by the way, infers in his paper, just noticed, that the Elephants whose remains are said to have occurred in the Boulder-clay must have lived previous to the accumulation of that formation. Dr. Bryce suggests that the strata containing the Elephant-remains may correspond with the Cromer forest-bed; and Mr. Jamieson infers the correlation of certain shell-bearing beds in Aberdeenshire with our English Red Crag.

The Rev. H. W. Crosskey's paper may be considered an appendix to those of Dr. Bryce, as the subject is the same, though the locality is different. In 1850, Mr. Smith, of Jordan Hill, described the occurrence of a bed of clay containing *Tellina calcarea*, intercalated between two masses of true Boulder-clay, and Mr. Crosskey now discusses the question whether the upper mass was really Boulder-clay. He comes to the conclusion that the upper deposit is a wash from a higher ridge of Boulder-clay, and that the shell-bed, which is on the slope of such a ridge, occupies the same position as the common shell-beds of the Glacial epoch in the West of Scotland; at any rate, he submits that the contrary has not been proved.

Considering how often the complaint has been made that the classification of our Post-tertiary deposits is in a more unsatisfactory state than that of any other portion of the geological series, we rejoice to find that the geologists of Scotland are working so hard and so earnestly at the subject; and we sincerely hope that the reproach will soon cease to be applicable to their series. At all events we have in this number of the Society's Journal four papers of very great value, and as they have appeared together, the date of their publication will doubtless mark an epoch in the history of the Post-tertiary beds of Scotland.

The next paper we shall notice is that by Mr. E. Ray Lankester, "On the Sources of the Mammalian Fossils of the Red Crag, and on the Discovery of a new Mammal in that Deposit allied to the Walrus." Its author is a very young palæontologist of great promise, who has already published two or three papers containing descriptions of new mammals from the Red Crag. In pursuing his researches he has been tempted, like some of his predecessors, to speculate on the sources whence this strangely heterogeneous fauna was derived. In the Red Crag we have, as Mr. Lankester remarks, "not one fauna, but

a mixture of selections from several." As regards the mammals there are, according to the author, Ziphioid Cetaceans, from the Middle Antwerp Crag, or an equivalent of it; Mastodon, Rhinoceros, Tapir, *Sus*, *Felis*, &c., from either a late Miocene or an early Pliocene deposit; and *Coryphodon*, *Hyracotherium*, &c., from our own Eocene deposits. Mr. Lankester does not pretend that his idea is new, as he states that it is merely an extension of the views formerly advanced by Mr. Searles Wood, sen.; but, unfortunately, it is precisely his extension that will be cavilled at, although Professor Owen has published the same opinion in general terms. Judged by the rules which should govern our processes of ratiocination, Mr. Lankester's argument may doubtless be faulty, as exceptions could be taken to most of its terms; but as in Geology we cannot expect, and rarely even attempt, to demonstrate with logical accuracy, so ought we to judge only of the probability of this view being correct, and not whether there cannot be found a loophole of escape for the Crag worshipper and his white elephant to creep through.

We must pass over the remaining papers in this number, several of which are of great interest, to enable us to say a few words on the second part of Dr. Falconer's great memoir "On the Species of Mastodon and Elephant occurring in the Fossil State in Great Britain," which is now published (unfortunately incomplete) posthumously, as a postponed paper, having been read on June 3, 1857. As an abstract of the paper was published in 1858, we shall merely give a very general sketch of what is now published in full. This second part refers entirely to the genus *Elephas*, the genus *Mastodon* having been described in the first part. Dr. Falconer divides *Elephas* into three sub-genera, namely, *Stegodon*, *Loxodon*, and *Euelephas*. The Stegodons and Loxodons have hypisomerous teeth, that is to say, they deviate from numerical symmetry by an augmentation of one ridge to the crown of the last "intermediate molar." The teeth of *Euelephas* are anisomerous, the ridges being more numerous, and augmenting by progressive increments corresponding with the increase of age. The Loxodons differ from the Stegodons in having the ridges of the teeth considerably more elevated and compressed, the latter sub-genus approaching more nearly to the Mastodons. The existing African elephant is a *Loxodon*, and the existing Indian species belongs to the sub-genus *Euelephas*. Dr. Falconer describes those species which illustrate the extinct English elephants, beginning with the Stegodons; and of our extinct forms he gives a full description of *Elephas* (*Loxodon*) *priscus* and *E.* (*Lox.*) *meridionalis*; he also begins the description of *E.* (*Euelephas*) *primigenius*, but the memoir is, unhappily, wanting in the remainder of the description of this species, as well as in the description of *E.* (*Euelephas*) *antiquus*, and in the general conclusions at which the author had doubtless arrived. These lacunæ are unfortunately the most important portions to English geologists, so that in this posthumous fragment we really have a kind of Pachydermatous "Hamlet"—without the prince.

VII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The 'Mineral Statistics for 1864' have been recently published. This National return may be regarded as the balanced ledger of the mining interests, and we look to it annually for the purpose of learning the progress of several of our most important industries. The way in which the transmuting power of the human mind has been brought to bear, with greater or less force, by the peoples of different countries, is a curious and instructive study. This has been in nearly all cases determined by the abundance of one or the other of the great divisions of the natural kingdom. The products of the vegetable world become the objects of manufacture to one country; those of the animal especially claim the attention of another; while the mineral stores receive the attention of the inhabitants of those lands which are, like our own, especially marked by the variety of rock formations, and, consequently, by the abundance and diversity of its minerals.

We are essentially a manufacturing people, but every branch of manufacture which we have made especially our own, depends upon the vast mineral resources which we possess. Without our coal and our iron, we should fail to maintain our position amongst nations, and although we do not depend so directly on our other metalliferous minerals, yet much of our prosperity and commerical power is to be traced to our mines of tin, of copper, of lead, and of other ores. With a view of showing this, we have made the following careful abstract from the 'Mineral Statistics' for last year. The quantity of coal produced from 3,268 collieries reached the enormous amount of 92,787,873 tons, which is valued at the pit's mouth,—that is, before any cost of carriage is incurred, at 23,196,968*l.* Of this we exported to foreign countries about eight million tons and a half. There is—owing we suppose to the different dates to which the respective returns have been made up—some discrepancy in the statement of the exports given in this book.

	Tons.
The Parliamentary Return gives	8,809,908
The Board of Trade	8,800,420
The General Summary of Exports to all countries, as given in detail .	8,063,846

Whichever return, however, is adopted, there is, in comparison with the returns of the previous year (1863), an increase of rather more than 500,000 tons in our coal exports. From this we learn that our manufactures, our steam engines on land, our steam vessels at sea, our locomotives, and our domestic fires consumed no less than 83,900,000 tons of coal during last year: verily, this is a serious drain upon our stores. Nothing has been published which can be regarded as satisfactory on the question of the duration of our coal fields. We must not, therefore, accept any of the conclusions which have been arrived at as strictly reliable. At the same time, the fact should not be lost sight of, that we are each year increasing the engineering

difficulties which accompany the mining for deep coal, and consequently increasing slowly but certainly the cost of production. With the increase of the price of coal to the manufacturer, there must of necessity ensue an advance of price to the consumer of the manufacture, whatsoever it may be. It therefore becomes a necessity to economize the consumption of coal in every direction, and to encourage the invention of machinery, by which the cost of "getting" coal may be, as much as possible, reduced.

Since we noticed in former numbers of the 'Journal of Science' the introduction of machines for cutting coal, several modified forms, of those of which we gave drawings, have been introduced, but there is not sufficient novelty in any of them to lead us, at present, to any special description of them. There is no doubt much ingenuity in several of those machines, but we delay noticing them until they have been perfected by experience in the coal pit.

Our iron produce is certainly next in importance to the coal. 613 Iron furnaces were in blast during 1864. To supply those, 10,064,890 tons of iron ore were required and obtained from our iron mines. From this, and some small parcels of Foreign ore imported, there were smelted 4,767,951 tons of pig-iron. This was distributed over 6,338 puddling furnaces, and by the gigantic aid of 705 rolling mills it was converted into merchant, bar, and other iron. In addition to this, we imported 53,918 tons of iron, most of which was employed in the manufacture of steel; and nearly 8,000 tons of steel of Foreign manufacture were also brought into the country.

In the present number of the Journal a paper appears on British gold. That paper contains the statistics of the production of this precious metal; we have therefore only to state in this place that 2,887 ounces of gold were procured last year from 2,336 tons of quartz, which were mined from the slate rocks of Merionethshire.

Our Cornish and Devonshire mines produced 15,211 tons of tin ore, which yielded of metallic tin 10,108 tons. This is in excess of any former year. It is surprising that, in the face of the evident accumulation of this metal in the hands of the smelters, and consequently, of a constantly falling price, so large a quantity of tin ore (black tin) should be forced upon the market. It is no doubt owing to the very unsatisfactory manner in which our mines are worked, and, to the necessity which exists, for the purpose of maintaining the price of shares, in the mining markets of London, and our other large towns.

The copper mines of the United Kingdom produced 214,604 tons of ore, which gave 13,302 tons of metallic copper. The copper mines of this country are showing evident indications of decline. The quantity of ore sold in 1863 was slightly in excess of 1864, but the metal obtained from it was less, proving that poorer ores are being sent into the market. Our importations of this metal were 93,304 tons, of copper ore and regulus 10,015 tons in bricks and pigs, and 14,924 tons in bars. Of this, by far the largest portion was from Chili and Cuba.

The British lead mines gave 94,433 tons of lead ore, and from this there were obtained 67,081 tons of lead and 641,088 ounces of silver,

the value of the lead being 1,448,959*l.*, and of the silver 176,299*l.* The production of Zinc is comparatively small, the total quantity for 1864 amounting to 15,047 tons only, whereas we imported 2,621 tons of Zinc ore and 31,281 tons of Zinc, more or less pure. Our importations of iron pyrites was also much in excess of our production. We need not detail the less valuable minerals; suffice it to say, the total value of the minerals obtained last year was 31,603,047*l.*, the value of the metals produced being 16,281,869*l.*

A Swedish engineer, M. Nobell, has proposed the use of nitro-glycerine instead of gunpowder for blasting purposes in mines. If fired by the electric spark, or the gunpowder match, the explosive force of this compound is considerable. In the course of the discussion in the Academy of Sciences of Paris on the use of this nitro-glycerine, it came out that M. Ascagne Sobrero, a young Italian chemist attached to the laboratory of M. Pelouze, treated in 1847 glycerine by a mixture of nitric and sulphuric acid, and obtained a nitro-glycerine having the aspect of olive oil—yellow, heavier than water, and insoluble in it, but soluble in alcohol and ether, and which possessed all the properties of gun-cotton as an explosive agent. The nitro-glycerine of M. Nobell is said not to detonate at the temperature of 100° Cent., nor by the action of a single spark. A commission, composed of MM. Regnault, Pelouze, Combes, Morin, and Chevreul, has been named to inquire into the application of this fluid for blasting in mines.*

Some experiments have been made in the tin mines of Altenburg, in Saxony, which appear to have been very satisfactory. The great advantages are the smallness of the holes required in the rock, and consequently the great saving of the time in the miner. Gunpowder has, it is stated, but one-tenth the strength of this liquid. The process of blasting with the nitro-glycerine is very easy. If there are any fissures in the rock, the hole or chamber must be first lined with clay, to render it water-tight. This being done, the nitro-glycerine is poured into the hole, a safety fuze, with a well-charged percussion cap, is introduced into it, and the hole is filled with water, no other tamping being necessary. Other experiments have been recently made in the presence of a committee of the Royal Cornwall Polytechnic Society in Cornwall, and the rending powers of this explosive compound has been proved to be most remarkable.

Shale Oil in New South Wales.—In the neighbourhood of Illawara an inflammable substance has been long known to exist. Recent examination has shown that this contains a large quantity of kerosene oil. Some of this shale having been collected and carried to Sydney, it was properly examined and found to be really of considerable value. The quantity of oil yielded by twenty-one pounds of shale, when subjected to distillation, was one gallon. It is stated that this oil can be produced and packed in tins at 1*s.* 6*d.* per gallon.

* 'L'Institut,' 10th July, 1865. No. 1646.

At the meeting of the Mining Engineers, at Manchester, several matters of great interest to the coal-miner were brought forward and discussed.* There were no questions, however, of sufficient general interest to occupy our space, especially as all the communications and the discussions thereon will be published by the associated societies of Newcastle and South Wales. The value of those meetings is great —and we are surprised, seeing how evident this has been rendered, by the progress of the Institutions of Mining Engineers in Newcastle and South Wales—that they have not been extended. The annual meeting of the Miners' Association of Cornwall and Devonshire was held at Falmouth, on the 31st of August. Several papers on the peculiarities of the mineral districts in Cornwall—on Mine Surveying, and on other allied subjects, were read; and a letter from Mr. Arthur Dean on the presence of gold in some of the Cornish pyritic lodes, especially in the large lode of sulphur ore at Dowgas, near St. Anstell. It was stated by the Honorary Secretary and founder of the Association, Mr. Robert Hunt, F.R.S., that three classes, for the instruction of the working miner in Chemistry and Mineralogy, were progressing most satisfactorily under the guidance of Dr. C. Le Neve Foster.

Mineralogy.

M. de Zepharovich, of the University of Prague, has transmitted to the Mineralogical Class of the Academy or Sciences at Vienna, a Memoir on the *Bournonite*, *Malachite* and *Corynite* of Olsa, in Carinthia.

The *Corynite* is a new species of pyrites, which is extremely abundant in the sulphate of lime and carbonate of iron of the explored beds of the mine at Olsa. The *Corynite* appears to belong to the nickeliferous pyrites, ranging between *Gersdorffite* and *Ullmannite*, appearing to be a compound of sulphide and arsenide of nickel, combined with a sulphite and antimoniate of nickel. The remarks on the other minerals have no general interest.

A new mineral, Iodide of Lead, has been discovered in Chili, containing 10 per cent. of lead. It is spoken of as being of high commercial value as an ore of lead, independently of the iodine which it contains.

Bismuth in large quantities is now being obtained by a small company of miners, in the Iljampu mountain, only just below the limits of perpetual snow. We alluded, in one of our early numbers, to the use of Bismuth, in some absurd attempts which had been made to transmute the baser metals. The following abstract, from a more extended table, shows the remarkable variations in the price of this metal dependent upon this delusion.

In 1844, Metallic Bismuth was 10*d.* the pound. In 1844 and 1845, it rose to 2*s.* 6*d.*, and this price continued to 1858, except on one or two occasions when the price rose to 4*s.* per pound. In 1861, the price of Bismuth suddenly advanced to 9*s.* 6*d.*; and in 1862 it reached 20*s.* the pound; since which time it has fallen back to 10*s.* 6*d.* The

* 'Colliery Guardian,' July 15 and 22.

principal uses to which this metal is applied, are in the manufacture of fusible metal, of calico-printers' rollers, and for medicinal purposes. This country is supplied chiefly from the Saxon and Bohemian mines. Although found in Cornwall, it is but rarely obtained in sufficient quantities for sale.

Professor Goeppert has published a book '*On the Organic Nature of the Diamond.*' The fact that diamonds when exposed to the intense heat of the voltaic arc are turned black—converted indeed into coke—is seized upon to prove that this precious gem cannot have been produced by igneous action. Diamonds are stated by Goeppert to have often on their surface, impressions of grains of sand, and sometimes of crystals, showing, it is contended, that they must have been in a soft state. It is found that sometimes they enclose other crystals, germs of fungi, and occasionally fragments of vegetation of a higher order. All the facts known, according to Professor Goeppert, appear to prove that the diamond is the result of vegetable change, representing, in fact, the ultimate condition of a series of decompositions.

Metallurgy.

A paper, "*Fabrication directe de l'Acier fondu au moyen des Gaz,*" by M. Aristide Bérard, was read at the meeting of the Academy of Sciences in Paris on the 17th July. To produce steel, the impurities of iron are removed by using alternately reducing and oxidizing agents in the gaseous condition. M. Bérard operates in a kind of reverberatory furnace with two soles, which are separated by a bridge; coke is placed on this bridge to remove free oxygen. While air is sent through the metal on one side, the other is treated with a mixture of hydrogen and carbonic oxide free from sulphur. The process is supposed to be thus explained:—During the period of oxidation part of the iron is converted into protoxide—the earthy metalloids—such as Silicium, Aluminium, Calcium, and the like, are oxidized, and combined with Silica to form Slags. The sulphur, phosphorus, and arsenic are oxidized and volatilized. In the period of reduction the oxide of iron is reduced, and the other metals remain in combination with the Silica, forming *Scoriæ*, which float on the surface. Any sulphur, phosphorus, or arsenic remaining is said to form now a volatile hydrogen compound. The final process is that of decarburation, which is effected by the air-blast. This process appears to us to partake, in all its main features, of the principles involved in that of Bessemer. It certainly involves many of the conditions which were experimented on, and rejected, ere the Bessemer process took its final form. We are also told that Manganese plays an indefinite part; the certain effect, however, being to facilitate the conversion of the iron into steel. Is this anything beyond the use of *Spiegel-Eisen?* The French Metallurgists are still continuing the discussion on the agents necessary for the production of cast-iron and steel. M. Marguerritte recently published a memoir on this subject, in which he gave many original and ingenious experiments. MM. Boivin and Loiseau have communicated to 'Les Mondes' some experi-

ments which they think are confirmatory of the views entertained by M. Marguerritte. They suppose the carburet of iron to be a definite compound, which is infinitely soluble in melted iron. Many of the experiments certainly appear to support this view, but there are many reasons why we hesitate to accept this explanation as the decision of a complicated problem.

M. Troost has interested the Academy of Sciences at Paris by an account of the process by which he has succeeded in obtaining the metal *Zirconium.* It will be remembered, by most of our readers, that the delicately tinted gem, the *hyacinth Zircon,* commonly called the *jargon,* contains this metal, which was separated by Berzelius, but which has not, before the experiments by M. Troost, been produced in a coherent form. By heating the double fluoride of Zirconium and potassium with one part and a half of aluminium, to a temperature required for melting iron, in a crucible made of gas retort charcoal, crystalline laminæ of Zirconium are formed around the button of Aluminium. From these the Aluminium can be removed by means of diluted Hydro-chloric Acid.

The pure metal thus obtained is a very hard substance of the colour of antimony, and much resembling it in lustre and brittleness. The density of crystallized Zirconium is 4·15; it is not attacked by either Sulphuric or Nitric Acids at ordinary temperatures, but is readily dissolved by Hydro-fluoric Acid. It is a bad conductor of electricity. M. Troost is still continuing his investigations, and we may therefore expect to know more of this rare and curious metal in a short time.

Our French neighbours boast of a new application of centrifugal force. Iron tubes are now made by calling this power into play. Into a cylinder of the required size, closed at each end, the necessary quantity of melted iron is poured, and a rapid motion is communicated to it. The melted metal is pressed against the sides of the cylinder; it cools while in motion, and the result is a perfectly uniform and straight tube. The machine is invented by a young workman named Auguste Larson, and the writer says* that the first trials are perfectly successful. For many years a similar process has been employed in this country, especially for small ornamental castings. The cylindrical casings of the oil vessels of the Moderator Lamps have been so made. The melted copper or bronze is poured into a cylindrical mould, which, being closed, is allowed to roll down an incline plane; here centrifugal force is called into play, and remarkably sharp castings are the result.

A very important experiment is about to be tried, on a sufficiently large scale, to determine its commercial value, by Messrs. Vivian and Sons, of Swansea. The "copper smoke" so called, which envelopes the town and destroys the vegetation in the valley and on the hills around it, is produced by the volatilization of sulphur from the copper ores which are smelted in the numerous and extensive works which are located on the margin of Swansea Bay. An eminent

* 'Les Mondes,' 20th July, 1865, p. 468.

authority writes "that 46,000 tons of sulphur are volatilized into 92,000 tons of sulphuric acid; that in the neighbourhood of Swansea 65,900 cubic metres, or nearly two millions and a half cubic feet, are projected into the atmosphere; and Le Play estimates the value of the sulphur dissipated at 200,000*l.* yearly."

M. Moritz Gerstenhöfer has invented a furnace, by means of which a considerable portion of this sulphur will be converted into a marketable product. Mr. Hussey Vivian writes, "We have had two calciners at work for some months, and are now building twenty-six more. As far as I can form an opinion, it (Gerstenhöfer's calciner) is a perfect success, and will put an end to all vapours arising from our calcining and roasting furnaces. I believe that when this furnace is universally adopted, the only vapours arising from our copper works will be those of the melting furnaces. At a rough guess, probably upwards of two-thirds will be condensed and turned to profitable account." The ores of copper smelted are usually oxides, carbonates, and sulphides. The two former produce no injurious consequences, but the latter, which is by far the most abundantly used, fills the air with sulphur vapour. In Gerstenhöfer's furnace the ore is so divided as it passes from the regulated hoppers at the top, that it shall fall on a triangular bar, and then on to similar bars below each other, and thus expose the ore to continued subdivision, till it reaches the bottom and is freed from the sulphur. The heat and oxygen converts it into sulphurous acid, which is constantly passing off through the side into leaden chambers, where it gets an additional supply of oxygen in the usual manner, and is collected as oil of vitriol. In the process no additional fuel is required, for the sulphur catching fire at the upper bars, the heat evolved suffices to keep the falling ore in a state of ignition.

Puddling by machinery appears to be making certain, although slow, advances. The apparatus erected at Dowlais by Mr. Menelaus is, by all who have seen it at work, pronounced to be, mechanically, perfect. The defect of the arrangement at present being the difficulty of securing the lining of the pear-shaped revolving furnace. This is thought by most ironmasters to be a difficulty which will be remedied after a little more experience has been gained.

A Swedish chemist has discovered a method of reducing the ores of Tungsten, and of obtaining the metal at once in a state of fusion. It is stated that ingots of the pure metal weighing several pounds are now shown in Stockholm, and that by the new method the cost of obtaining tungsten does not exceed a few shillings the pound.* Since this metal is found to give great toughness to iron, it may become very valuable as an alloying agent, and this process may be of importance. At Drake Walls, at Kit Hill, and East Pool, in Cornwall, almost any quantities of wolfram can be obtained, and if brought into use, that which is now a waste material and an annoyance, would become both useful and profitable.

* 'Mechanics' Magazine.'

VIII. PHYSICS.

Light.—With few exceptions spectroscopes and spectrum observations constitute the principal novelties in this branch of science, during the last few months. Foremost among the latter may be mentioned a lecture by Mr. Huggins, delivered before the Royal Institution, on the physical and chemical constitution of the fixed stars and nebulæ. The speaker stated that spectra might be divided into three orders, *viz.* :—

1. A continuous spectrum, unbroken by bright or dark lines, which indicates that the light has not undergone any modification on its way to us. Also, that its source is an opaque body, almost certainly in the solid or liquid state. Such a spectrum gives no information of the chemical nature of the substance from which the light emanates.

2. A spectrum of bright lines separated by dark spaces; this informs us that the source of the light is matter in the gaseous state. By a comparison of the bright lines of such a spectrum with the lines of terrestrial flames we may discover whether any of these terrestrial substances exist in the distant and unknown source of light. The spectra of many of the nebulæ are of this order.

3. A continuous spectrum interrupted by dark lines; this shows that the light has passed through vapours which have deprived it of certain refrangibilities by a power of selective absorption.

Since Kirchhoff has shown that these dark lines agree exactly in position with the bright lines which the vapours would emit if in a luminous state, a comparison of these dark lines with the bright lines of terrestrial vapours will indicate whether any of these are present in the vapours through which the light has passed. The spectra of the fixed stars are of this order. In the case of these bodies, the vapours that produce the dark lines immediately surround them, and are those of the substances of their surfaces. The chemical constitution of the stellar atmospheres will correspond, at least in part, with that of the stars themselves.

What are the stars? Endeavour with the most powerful telescopes to approach them, still they assume no apparent size; they remain under the highest magnifying powers what they appear to the unaided eye—diskless, brilliant points.

Until quite recently, our knowledge of the stars might be summed up thus:—That they shine; that they are immensely distant; that the motions of some of them show them to be composed of matter endowed with a power of mutual attraction.

Since these bodies are self-luminous, we may hope to gain by prismatic analysis more information of their nature, than it is possible to do of the planets, which all shine by reflecting the sun's light.

The results on the light of the stars Aldebaran and α Orionis (Betelgeux) are given in the following table:—

Elements Compared with Aldebaran.

Coincident.			Not Coincident.	
1. Hydrogen	with lines	C and F	Nitrogen	three lines
2. Sodium	„	double line D	Cobalt	two lines
3. Magnesium	„	triple line *b*	Tin	five lines
4. Calcium	„	four lines	Lead	two lines
5. Iron	„	four lines and E	Cadmium	three lines
6. Bismuth	„	four lines	Barium	two lines
7. Tellurium	„	four lines	Lithium	one line
8. Antimony	„	three lines		
9. Mercury	„	four lines		

70 lines measured.

Elements Compared with α Orionis (Betelgeux).

Coincident.			Not Coincident.	
1. Sodium	with	double line D	Hydrogen	C and F
2. Magnesium	„	triple line *b*	Nitrogen	three lines
3. Calcium	„	four lines	Tin	five lines
4. Iron	„	three lines and E	Lead	two lines
5. Bismuth	„	four lines	Gold?	
6. Thallium?	„		Cadmium	three lines
			Silver	two lines
			Mercury	four lines
			Barium	two lines
			Lithium	one line

80 lines measured.

The 70 or 80 lines measured represent some of the stronger only of the numerous lines which are seen in the spectra of these stars. Some of these are probably due to the vapours of other terrestrial elements which have not been compared with these stars. It would be assumption to suppose that the sixty-five so-called elements constitute in its entirety the primary material of the universe. Doubtless in the spectra of the stars the chemist is introduced to many new elements—would that it were possible for him to recognize and to isolate them!

From the additional knowledge which these spectrum observations give us, we are entitled to conclude that in plan of structure the stars closely resemble the sun. The source of their light is probably solid matter, in a highly incandescent state. Around this photosphere, there exists an atmosphere of vapours of such of the elements of the stars as are volatile at their high temperature.

A community of matter appears to exist throughout the visible universe, for the stars contain many of the elements which exist in the sun and earth.

It is remarkable that the elements most widely diffused through the host of stars are some of those most closely connected with the living organisms of our globe, including hydrogen, sodium, magnesium, and iron.

Spectrum observations applied to the nebulæ appear to authorize the following opinions of the nature and structure of those of the nebulæ which gave a spectrum of bright lines:—

1. The light from these nebulæ emanates from intensely heated matter existing in the state of gas. This conclusion is corroborated

by the great feebleness which distinguishes the light from the nebulæ. A circular portion of the sun's disk subtending 1′ would give a light equal to 780 full moons, yet many of the nebulæ, though they subtend a much larger angle, are invisible to the naked eye.* Upon the earth, luminous gas emits a light which is very inferior in splendour to incandescent solid matter.

2. If these enormous masses of gas are luminous throughout, the light from the portions of gas beyond the surface visible to us would be in a great measure extinguished by the absorption of the gas through which it would have to pass. These gaseous nebulæ would, therefore, present to us little more than a luminous surface. This consideration may assist in explaining the strange apparent forms of some of the nebulæ.

3. It is probable that two of the constituents of these nebulæ are the elements, hydrogen and nitrogen, unless the absence of the other lines of the spectrum of nitrogen indicates a form of matter more elementary than nitrogen. The third gaseous substance is at present unrecognized.

4. The uniformity and extreme simplicity of the spectra of all these nebulæ oppose the opinion that this gaseous matter represents the "nebulous fluid" suggested by Sir William Herschel, out of which stars are elaborated by a process of subsidence and condensation. In such a primordial fluid all the elements entering into the composition of the stars should be found. If these existed in these nebulæ, the spectra of their light would be as crowded with bright lines as the stellar spectra are with dark lines.

The supposition can scarcely be entertained that the three bright lines indicate a more primary and simple condition of matter; for then, if the process of elaboration into stars be now taking place, we should expect to find in some of the nebulæ, or in some parts of them, a more advanced state towards the formation of the separate elements of which we now know the stars to consist. Such an advance would be indicated by an increased number of bright lines. It is difficult to suppose that the excessively high temperature of the nebulæ keeps in check affinities by which, if unrestrained, the formation of the elements would take place; for in some of the nebulæ a nucleus exists, which from its continous spectrum, its greater brightness, and apparent separation from the surrounding gas, we must regard as containing solid or liquid matter. At a temperature at which matter can become liquid or solid (though from peculiar conditions that temperature may be a very exalted one), we cannot suppose the formation of the chemical elements to be restrained by excessive heat.

5. A progressive formation of some character is suggested by the presence of more condensed portions, and in some nebulæ, of a nucleus. Nebulæ, which give a continuous spectrum, and yet show but little indication of resolvability, such as the great nebula in Andromeda, are not necessarily clusters of stars. They may be

* See 'Outlines of Astronomy,' by Sir John F. W. Herschel, p. 616. Seventh edition.

gaseous nebulæ, which by the loss of heat or the influence of other forces have become crowded with portions of matter in a more condensed and opaque condition.

6. If the observations of Lord Rosse, Professor Bond, and others are accepted in favour of the partial resolution of the annular nebula in Lyra, and the great nebula in Orion into discrete bright points, these nebulæ must be regarded not as simple masses of gas, but as systems formed by the aggregation of gaseous masses. Is it possible that the permanence of general form of these nebulæ may be maintained by the motions of these separate masses?

7. The opinion of the enormous distance of the nebulæ from our system, since it has been founded upon the supposed extent of remoteness at which stars of considerable brightness would cease to be separately visible in our telescopes, has no longer any foundation on which to rest in reference at least to those of the nebulæ which give a spectrum of bright lines. It may be that some of these are not more distant from us than the brighter stars.

8. As far as the speaker's observations extended, they appeared to be in favour of the opinion that these nebulæ are gaseous systems possessing a structure and a purpose in relation to the universe altogether distinct from the great cosmical masses to which the sun and the fixed stars belong. What is this special purpose? Many fascinating theories present themselves in connection with the great problems of the conservation of the energy of the universe, and of the source and maintenance of solar and stellar heat. In the opinion of the speaker, science will be more advanced by the slow and laborious accumulation of facts than by the easier feat of throwing off brilliant speculations.

A paper on the spectrum of nitrogen was sent by Mr. Waltenhofen to a recent meeting of the French Academy, in which he states that in an atmosphere of nitrogen properly rarefied the violet rays disappear before the blue and green. The author's observations lead him to believe that nitrogen is a compound body.

Professor J. Müller has examined the wave length of the blue indium line, by the method and by means of the grating which the author described some time ago. He finds it to be 0·000455 millim.

When the light of an indium flame is decomposed by the prism it shows *two* blue lines, one of which, very intense, is situated close to the blue strontium line, but a little further towards the violet end of the spectrum; the other line is still more refrangible, but so much fainter that it cannot be perceived at all in the spectrum produced by means of a grating.

A valuable application of the spectroscope to toxicological purposes has been made by Hoppe-Seyler, who has described it before the French Academy. He applies it to the recognition of poisoning by carbonic oxide. The method is founded on the following observation:—Blood treated with carbonic oxide alone shows the same spectrum as blood containing oxygen, and, if sulphide of ammonium

be added, no change will take place even after several days; but if blood which contains only oxygen in solution is treated with sulphide of ammonium, an almost immediate change takes place, and only one band is seen about midway between **D** and **E**. By this unchangeability of blood holding carbonic oxide in solution on the addition of sulphide of ammonium, the author detects the presence of the poisonous gas. It is worth quoting that the author has found that, by continuing artificial respiration for a time, animals poisoned by carbonic oxide have been restored to consciousness, the gas being expired as carbonic acid.

Mr. Gassiot has communicated to the Royal Society a description of a rigid spectroscope, which he has had constructed with a view to ascertain whether the position of the known and well-defined lines of a spectrum is constant, while the co-efficient of terrestrial gravity under which the observations are taken is made to vary. The idea of it was suggested by Professor Tait and Mr. Stewart, and Mr. Browning was consulted as to the practicability of constructing the spectroscope. He considered such an instrument could be made, with sufficient rigidity in all its parts, to examine with great accuracy any given portion of the spectrum which might be selected, and for which the prisms would have to be adjusted and fixed. The observations having been originally intended to be made in balloon ascents, the construction of the spectroscope had necessarily to be considered in reference to some portable and easily manageable form, and it was particularly desirable that its weight should be as low as possible. The instrument was completed so as to weigh little more than 40 lbs., but it was soon found that the errors arising from changes in the temperature were so variable, that no good results could have been obtained in balloon ascents, where rapid fluctuations of temperature would continually occur; it was then determined to attempt the construction of a rigid spectroscope, with which observations might be made, either on board a vessel or on land in various latitudes, and as the question of the total weight of the apparatus became no longer of paramount importance, an alteration in the construction of the instrument was decided upon. Three large prisms are used, with sides 2½ inches high and 3 inches long, the light being reflected back through them, so as to make the whole equal to that which would be produced by five prisms if employed in the ordinary manner. Thermometers were inserted into holes drilled in the prisms, so that the exact temperature of these and also of the surrounding atmosphere can be taken. The performance of the instrument is very satisfactory; Mr. W. Huggins has seen two bright lines between the **D** lines produced by the flame of a common spirit lamp; and several persons have seen on different occasions from five to seven lines between the **D** lines in the solar spectrum. This is equal to the performance of the large spectroscope, with which the solar spectrum is now being mapped at Kew Observatory. Numerous observations of the different readings of one of the **D** lines for variations of temperature are given, and the result of observing under a varied temperature of 40° Fahr., the

carrying of the instrument from the Minories to Kew Observatory, and subsequently to the Royal Society without affecting the readings may be taken as evidence that with ordinary care the spectroscope can now be used with reliance as to the rigidity of its construction, thus fulfilling the conditions which are indispensable for obtaining correct observations.

Heat.—In a former number we gave a brief account of some experiments by Professor Tait and Mr. Stewart on the phenomenon of the heating of a disc by rapid rotation; some further results have lately been communicated by these gentlemen to the Royal Society. In their apparatus a slowly revolving shaft is carried up through a barometer tube, having at its top the receiver which it is wished to exhaust. When the exhaustion has taken place it is evident that this shaft will revolve in Mercury. In the receiver the shaft is connected with a train of toothed wheels, and ultimately causes a circular disc to revolve 125 times for each revolution of the shaft. Two insulated wires, connected with a Thompson's reflecting galvanometer, are carried through two holes in the bed-plate of the receiver, and are then connected with a thermo-electric pile having the usual reflecting cone attached to it. The outside of the pile and of its attached cone is wrapped round with wadding and cloth, so as to be entirely out of the reach of currents of air. The vacuum-gauge is on the syphon principle, and there is every reason to believe that it is perfectly deprived of air; and it is only necessary to add, that the whole is covered over with an airtight glass shade, 15 inches in diameter and 16 inches high. The galvanometer and thermo-electric pile were sufficiently delicate, that if the temperature of the disc were to rise 1° Fahr. this would be denoted by a change in the position of the line of light equal to fifty divisions of the scale. In these experiments the disc is rotated rapidly for half a minute, making 2,500 revolutions, and the heating effect was recorded by the pile. The object of this paper is to investigate the origin of this heating effect. In the endeavour to account for this result, the authors consider that we are reduced to choose between one of two causes or to a mixture of the two.

1. It may be due to the air which cannot be entirely got rid of.
2. It is possible that visible motion becomes dissipated by an ethereal medium, in the same manner and possibly to nearly the same extent as molecular motion, or that motion which constitutes heat.
3. Or the effect may be due partly to air and partly to ether.

The authors give experiments to prove that only a very inconsiderable portion of the effect observed depends upon the mass of air left behind; neither does the effect appear to be due to fluid friction.

M. Dufour, of Lausanne, has made some experiments to ascertain whether other gases behaved like atmospheric air in the phenomenon of ebullition under different pressures. He employed hydrogen, carbonic acid, and coal gas, and found that when water saturated with either of these gases was heated to boiling in an atmosphere of the same gas, the phenomenon proceeded exactly as if the liquid were in the presence of air. The ebullition showed nothing unusual, and the

temperature at which it took place was only raised one or two degrees. He concludes that the difficulty gases have in quitting liquids holding them in solution comes of a purely physical adhesion, and not of a chemical affinity.

A paper by M. Fizeau, on the Dilatation of the Diamond, and Crystallized Protoxide of Copper under the influence of heat, presented to the Academy of Sciences at their sitting in June last, contains some curious observations.

The author finds that these bodies, like water, present a maximum of density at a certain temperature. The diamond, for example, has its maximum at $-38 \cdot 8°$ C., and protoxide of copper at 4°. M. Fizeau has also determined the co-efficients of dilatation in these two bodies. These are the first two solid bodies in which the maximum of density has been satisfactorily determined, although the probability of a variation with temperature has been shown.

The thermic equivalent of magnesium has been determined by Dr. T. Woods,* by a method described by him in 1852, namely, by dissolving the metal in dilute sulphuric acid, marking the rise of temperature of the fluid and correcting the result by making the proper allowances for the heat absorbed by the decomposition of the water, and that evolved by the combination of the magnesia with the acid. The result at which the author has arrived, is that the quantity of heat developed by the combustion or oxidation of an equivalent of magnesium is exactly twice as much as that produced by the oxidation of an equivalent of zinc. Zinc will raise the temperature of 1,000 grains of water $9 \cdot 6°$ Fahr. by the combustion of 4 grains or 1 equivalent, oxygen = 1. Magnesium by the combustion of $1\frac{1}{2}$ grains, or 1 equivalent, will raise the temperature of 1,000 grains of water $19 \cdot 2°$ Fahr. This is the greatest amount of heat produced by an equivalent of any substance with which we are acquainted.

A useful paper on the easily fusible alloys of cadmium has been published by Dr. C. R. von Hauer. The alloys were made by fusing the ingredients in a covered porcelain crucible at the lowest possible temperature. After stirring with a glass rod, the fused mass was poured upon a cold metal plate, where it instantly solidified. The specific gravity and the melting point were determined after the alloy had been so melted and cooled two or three times. In the two or three fusions a partial oxidation of the metals takes place, which occasions a slight alteration in the equivalent proportions, and which it is almost impossible to avoid. The melting point was determined under hot water, and also by placing a thermometer in the fused mass without water. Under water the alloys quickly oxidize. They have also the property of becoming pasty below their proper melting point, which may lead to error in the determinations. The author's determinations were made when the alloy was really fluid.

The following table gives the equivalent proportions of the

* 'Phil. Mag.,' July, 1865.

ingredients in some of the more easily fusible alloys with their melting points:—

Equivalent proportions.	Melting point.
$Cd\ Sn\ Pb\ Bi$	68·5°C
$Cd\ Sn_2\ Pb_2\ Bi_2$	68·5°C
$Cd_3\ Sn_4\ Pb_4\ Bi_4$	67·5°C
$Cd_4\ Sn_5\ Pb_5\ Bi_5$	65·5°C

Lipowitz states that an alloy composed of three parts by weight of Cd, 4Sn, 8Pb, and 15Bi melts at 60°C; but the author of this paper observes that such a compound only becomes perfectly fluid at 70° C.

The melting point of an alloy of two parts Cd, 3Sn, 11Pb, and 16Bi is still higher—namely, 76·5°C.

The following mixtures had the same melting point:—

One part by weight of		Cd, 2Sn, 3Bi	perfectly fluid at 95°C
Two parts	„	Cd, 3Sn, 5Bi	
One part	„	Cd, 1Sn, 2Bi	

The author adds the following determinations of melting points:—

Proportions.	Melting point.
1 part Cd, 6Pb, 7Bi	88°C
Cd, 2Bi, 3Pb	89·5°C
2Cd, 4Bi, 7Pb	95°C

MM. Ste Claire Deville, Caron, and Troost have communicated a paper to the Academy of Sciences, in which they give their method of making rubies artificially. Fluoride of aluminium, with a small quantity of fluoride of chromium, is placed in an earthern crucible, which has been carefully lined with calcined alumina, just in the same way as a crucible is lined with charcoal. In the centre of this crucible is one of platinum, containing the boracic acid, around which the fluorides are disposed. The outer crucible is well covered. When this apparatus is exposed to a temperature sufficiently high, the fluorides volatilize, and come in contact with the vapours of boracic acid from the inner crucible, above and around which the rubies are deposited. The violet red tint of these is said to be exactly like that of the most beautiful natural stones.

In a memoir on the extraction of sugar, by M. Alvaro Reynoso, of Havanna, read before the French Academy, he gives a most ingenious utilization of the effects of cold in getting rid of the bulk of the water in the juice. By a process described in his memoir, he submits the juice to a very low temperature, and so gets a magma, composed of thick syrup and little lumps of ice. He separates the syrup from these by means of a centrifugal machine, and then evaporates quickly *in vacuo.*

A very ingenious addition has been made to the Lenoir engine by M. Arbos. The engine would often be extremely useful where gas could not be procured, and to make coal-gas would be impracticable. In a very simple apparatus M. Arbos vaporizes water, and passes the

vapour over red-hot charcoal dust. The mixture of carbonic acid, carbonic oxide, and hydrogen produced is then passed through milk of lime, to remove the first, and the other two go on to be mixed with air, and exploded in the cylinder of the engine. Extending the use of the engine as mentioned above, M. Arbos's apparatus effects a great saving in the cost of working the machine. Gas produced for two francs will do the work of six or eight francs' worth of coal gas.

A new combustible has been invented by a gentleman appropriately named Stoker, which is likely to possess some useful properties. It appears to be very pure charcoal, finely ground and made into a paste with starch. The paste is moulded into cakes or balls of different sizes, and then dried. When perfectly dry these may be lighted with a lucifer match, and will continue to burn steadily, like German tinder, without giving flame or smoke. The combustible is intended for heating urns, chaufferettes, &c.

Electricity.—In our last "Chronicles" we gave a brief account of a theory of imponderables, laid before the Academy of Sciences by M. G. Martin. In reference to this subject, two communications have reached us from gentlemen who consider the theories there put forward as sufficiently valuable to be worth claiming, on the ground of previous publication. The first is from Mr. McGauley, who it seems sent a memoir, in which this theory was developed, to the Academy, in May, 1862. It was then referred to a commission, consisting of MM. Pouillet and Fizeau, who have never reported upon it. In an article in the 'Scientific Review' the author states that "three years have confirmed the conviction his researches had long led him to entertain, that the imponderables are really material elements, subject, like all others, to definite laws of combination." We extract the propositions laid down by the author at the commencement of his memoir:—

"*Motion, Electricity, Heat, and Light, consist of the same Constituents, either Singly or in Combination.*

"I. The simplest form of motion (including nervous energy), electricity, heat, and light, is an element of motion in the latent state—that is, combined with matter.

"II. When an element of motion is liberated from combination with matter, by the neutralizing action of a motive element of the opposite kind—that is, 'when two opposite motions destroy each other,' the two electricities are set free, and when these combine, Heat is the result.

"III. When one of the calorific elements is in excess (being combined as a motive-element), the resulting heat becomes either one of the coloured rays of the solar spectrum, or an actinic ray, according to the amount of such excess, and is the more refrangible in proportion to that amount. And it is probable that the nature of the light which results depends on which calorific element (electric element) is in excess.

"IV. Both the heat elements are set free, under the form of the two electricities, during ordinary combustion, but only one of them during galvanic action.

"V. Motion is never produced, except by decomposition of heat, or by liberation of the calorific elements, during chemical action, which is true, even when the decomposition is due to electricity or electro-magnetism. And motion is never destroyed without heat being formed again, except when the calorific elements are prevented from uniting."

The second communication on this subject is from Mr. A. J. Cameron. In this letter the author says, that many years ago, in a paper which was read by Professor Gregory, and also by several others, he *demonstrated* that the two electricities when uniting formed caloric; but more than this was shown, for it would appear that after they had combined, they formed *all kinds of matter*, solid, liquid, and gaseous! We think Mr. Cameron has certainly no reason to accuse either Mr. Martin or Mr. McGauley of having anticipated him in that discovery.

M. Becquerel has published some new observations on thermo-electric piles of sulphide of copper. The author first described the way in which he prepared the sulphide of copper. He places a quantity of sulphur in a crucible and heats it to fusion. When this occurs, which is known by the escape of sulphur vapour, he immerses in the melted sulphur a plate of copper previously heated to dull redness, and leaves it in the crucible until all the sulphur is volatilized. He then removes the plate of copper coated with sulphide, cools it rapidly by dipping it into cold water, and finally detaches the coating of sulphide. This is then fused and run into bars or plates for the pile. As a negative element he employs *maillechort* (a nickel alloy resembling argentine). The author remarks that bars made of the same sulphide show a very unequal action, and that they should be tested before employed for a battery. In a note he mentions that Rhumkorff has found that the addition of $\frac{1}{25}$th of sulphide of antimony renders the action regular, although it somewhat diminishes the power. The ends of the bars of sulphide must be encased by the metal to prevent reduction when heat is applied direct, as by a gas flame. The author next proves that the current is developed by differences of temperature, and not by any chemical change in the sulphide, by showing that a battery has kept in action for a month with one extremity near the melting point of lead without loss of weight in the bar of sulphide of copper. M. Becquerel goes on to compare the electro-motive force of this battery with other thermo-electric piles, and shows that its power is much higher than that of the alloy of antimony and zinc employed by Marcus. It is only available, however, when the effects of tension are required.

In some curious statistics on the subject of death by lightning, given in a note by M. Boudin before the French Academy, it appears that during the period 1835–1863, 2,238 individuals were killed in France. The most in one year was 111; the fewest, 48. Among the

880 persons killed from 1854 to 1863, only 243 were females, which will be 26·7 per cent. In England the proportion of females killed is only 21·6 per cent. In many cases, M. Boudin says, when the lightning has fallen upon a group of people of both sexes, it has only killed the males and spared the females.

In several cases, however, when the electric fluid has fallen upon a flock attended by shepherds, it has only killed the sheep and spared the shepherds. M. Boudin states that there have been many instances of beeches struck with lightning, and that there are at least two examples of individuals struck more than once in the course of their lives; one man, indeed, was struck three times in as many different parts of his body, and another man was struck twice in his left foot. The statistics prove the danger of standing under trees in a storm.

M. Boudin also relates two instances in which the corpses of individuals killed by lightning seemed to be charged with electricity like Leyden jars, for in each instance people going to the assistance of the deceased received violent shocks.

IX. ZOOLOGY AND ANIMAL PHYSIOLOGY, Etc.

Dr. Richardson has recently communicated to the Royal Society a very remarkable Memoir, on the possibility of restoring the life of warm-blooded animals in certain cases where the respiration, circulation, and ordinary manifestations of organic motion are exhausted or have ceased. The object of the inquiry was to discover the best means to be adopted for fanning into active life the animal fire which is expiring but is not suspended; and secondarily to solve the question, whether animal combustion cannot be re-established when it appears to have been extinguished; and whether so-called vital activity would not be spontaneously manifested upon such re-establishment of animal combustion. The author is led to the conclusion, which he thinks admits of direct demonstration, that artificial respiration, in whatever way performed, is quite useless from the moment when the right side of the heart fails in propelling a current of blood over the pulmonic circuit, and when the auriculo-ventricular valve loses its tension on contraction of the ventricle. Only is artificial respiration useful when the blood from the heart is being still distributed over the capillary surface of the lungs—the process is simply one of fanning an expiring flame, which once expired will not, in spite of any amount of fanning, re-light. The further conclusion to which he is led goes, however, beyond the process of artificial respiration: returning again to the same simile, Dr. Richardson ventures to report that, even when the heart has ceased to supply blood to the pulmonic capillaries, during the period previous to coagulation, the blood may be driven or drawn over the pulmonic circuit, may be oxidized in its course, may reach the left side of the heart, may be distributed over the arteries; and that, thus distributed, it possesses the power of restoring general muscular irritability and the external manifestations of life. Hence he infers that

resuscitation, under the limitations named, is a possible process, and that it demands only the elements of time, experiment, and patience for its development into a demonstrable fact in modern science. We have not space to follow Dr. Richardson through the systematic series of experiments which lead to this result, but we may add, that the present memoir is preliminary, and that he promises to return with new results which are in course of development. One very remarkable circumstance may be recorded, which in the author's words is as follows:—"Since this paper was laid before the Society I have determined, by a direct experiment, that *rhythmic stroke* is of the first importance (in artificial circulation) for restoring muscular contraction. By means of a machine, which can be worked either by the hand or by electro-magnetism, I was enabled, assisted by my friends Drs. Wood and Sedgewick, to introduce blood heated to 90° Fahr. into the coronary arteries of a dog by rhythmic stroke, and at the same rate as the stroke of the heart of the animal previously to its death. The result was that in one hour and five minutes after the complete death of the animal, its heart, perfectly still, cold and partly rigid, relaxed, and exhibited for twenty minutes active muscular motion, auricular and ventricular. The action, which continued for a short time after the rhythmic injection was withheld, was renewed several times by simply re-establishing the injection.

Mr. Blyth, writing to the 'Natural History Review,' gives some remarkable instances of the reappearance of lions in some parts of India, from which they were supposed to be extirpated. He observes that during the whole of his twenty-two years' residence in India, not a single instance had been recorded of a lion having been observed in any part of the country, excepting in the province of Kattywar, in the peninsula of Guzerat, to which locality, in the general opinion of sportsmen and others, the species is now restricted as an Indian animal. The lion was supposed to be extirpated in Harriana in 1824; one was killed in the Nerbudda territory so late as 1847–8; since which it does not appear to have been heard of in those parts until last year, when in August, Lieut. Clarke, R.A., was out shooting near Dusay, on the borders of Rajpootana, and was sadly mangled by a lioness, and had to suffer amputation of his right arm. Later, in 1865, March 19th, Lieut.-Col. Tytler writes that a party of officers were out shooting small game on foot, when to their horror three lions sprang out before them, two males and a female. They fired: one of the males fell dead and the other wounded, and was found dead next day. Lions had not been heard of in that part of the country for at least thirty years.

Dr. Davy, in the Proceedings of the Royal Society, gives the results of his observations upon the temperature of the common fowl, made at different seasons of the year, showing that the temperature of this bird ranges from 107° to 109°, and that the male possesses a somewhat higher temperature than the female. Hunter assigned to it a temperature no higher than between 103° and 104°, a degree reached and even exceeded by some mammals. He also gives the results of his experiments on the air expired by a certain number of

birds, and on the length of time birds are capable of retaining life under water, which varies much in different species,—being in the duck as much as ten minutes.

We read in the 'Comptes Rendus' an account of the reproduction of some Mexican Axolotls in the Jardin des Plantes, as observed by M. Auguste Dumeril. This being the first time that such an event has taken place under scientific eyes, is a matter of great interest. The ovum is at first similar in appearance to those of other batrachian reptiles, and consists of a black vitelline sphere contained in the centre of a clear vitelline membrane, which is itself contained within an albuminous envelope. The young embryo, in about twenty-eight or thirty days after spawning, becomes separated from the shell, by the aid of violent movements, and then measures 0·015 of a millimetre, and possesses branchiæ which are much less elaborate in their divisions and ramifications than they become in the adult form. A second stage of development may be reckoned, embracing the period when the posterior pair of limbs appears, but M. Dumeril has not yet precisely made out how long elapses between this period and the rupture of the egg. The anterior pair makes its appearance in the earliest stage, but some months pass before the posterior limbs are developed.

M. Poluta, in the 'Annales des Sciences,' gives the results of some researches upon the duration of the life of fishes out of the water, which varies greatly, so that while the sturgeon will exist several hours deprived of its natural element, it is well known that the herring dies in about a minute. This circumstance is not dependent upon a different structure of the respiratory organs, but upon the tenacity of life in the animal fibre, which is in inverse relation to the quantity of oxygen necessary to the support of life in the organism. The herring requires more oxygen for the same weight of body than the sturgeon; and the circumstances which appear to prolong the life of fishes out of the water appear to be these, *viz.* the cylindrical form of the body, the presence of water in the branchial chambers, and the absence of scales from the skin; while the lateral compression of the body, the aggregation of the leaves of the branchiæ in a mass, and the existence of scales have a contrary effect: for fishes with cylindrical bodies, when removed from the water, rest tranquilly upon the ground, and their branchiæ have free play, while the laterally compressed fishes lie upon the side, and cannot distend the branchiæ of the lower side. With regard to the scales, those fishes which have them most deeply implanted in the skin live longest, while those in which they readily separate, as the herring, are very short lived; and the same circumstances may be observed in the case of lizards, tortoises, &c., whose tenacity of life is very great, and in inverse relation with the quantity of oxygen necessary to sustain life, while it is in direct relation to the depth of implantation of their scales.

The operculum of univalve shells has given rise to different opinions as to its homologies, some supposing it to answer to the second valve of bivalves, and the opercular mantle as correspondent

with one moiety of the mantle of the bivalve, while others regard the operculum as homologous with the byssus. Dr. Mörch reviews these opinions in the 'Annals,' and traces the cleft of the mantle in some univalves, as in the dentated furrow of *Monoceros*, *Ancillaria*, *Pseudoliva*, and chiefly in *Carinaria*, in which genus the keel is formed by the two sides of the shell, which are pressed against each other in such a manner that a piece of paper can be introduced into the middle of the keel as far as the fœtal shell. The shell of the young Dentalium is also split throughout its whole length. Also in the Acephala nearly all the organs are double; there are two ovaria with distinct orifices, two kidneys, two pairs of labial palpi, two pairs of gills. It seems therefore probable that the Acephala have also two shells originating in the same way. This duplicity is very indistinct in the univalves, and becomes rarer and rarer in the higher mollusca. The larva of *Anodonta* has in each shell a distinct byssus bundle, and a distinct intestinal channel with distinct oral orifices. Does the opercular lobe then, with its operculum, represent one lobe of the mantle and its shell in the bivalves, or is it something else? The fact of the operculum co-existing with the byssus in the same univalve, which sometimes happens, proves that Lovén's opinion that the operculum is homologous with the byssus cannot be correct. It must be also remembered that it is not known how the byssus of univalves is formed. The *float* of Ianthina which attaches the animal to the surface of the water is probably homologous with the byssus, judging from its ventral position. In Acephala it is generally corneous, but in *Anomiæ* it forms a calcareous plate (the plug), possibly corresponding with the opercular valve in Hipponyx, which may be considered as a calcareous secretion of the ventral face of the foot. The epiphragm of the Helices would also be homologous, if this plate be really a secretion of the foot, but it is probably secreted by the mantle like the septa of Vermeti. It appears that all parts of the skin in Mollusca can secrete a shell. In the Bullidæ and some Pellibranchs there are thick calcareous plates in the stomach.

As supplementary to the remarks lately made upon the special hairs of Crustacea, it may be added that MM. Claus and Sars have independently investigated the Schizopods of the family Euphausidæ with regard to the organs alluded to by Dana, Semper, and Kroyer, and regarded by Semper as eyes and by Kroyer as auditory organs. They are spherical bodies of a reddish colour, situated at the base of several of the thoracic legs and at the first four pairs of abdominal appendages. Both of the authors above mentioned have demonstrated the correctness of Semper's view, although besides these pedal eyes, the animals possess the two large compound eyes common to all Decapods. Each of the thoracic and abdominal eyes receives a special nerve from the ventral ganglionic chain. The organ itself is a spherical bulb moved by special muscles, and in it may be distinguished a crystalline lens, a vitreous body, a pigment layer, and a retina of complex structure. The existence of a crystalline lens distinct from the cornea is very striking, for in other Crustacea no true crystalline lens exists, its function being performed by the thickened and inflated

cornea. According to M. Claus the position of the four pairs of abdominal eyes is very remarkable : the first pair looks forward, the last pair backwards, and the two intermediate pairs downwards.

Dr. McIntosh describes the internal parasites of *Carcinas Mœnas*, or the common shore-crab, consisting of a trematode larva and Ascaris. He found adhering to the sheaths of the nerves from the great thoracic ganglion, minute specks in groups of two and three. The same bodies were found in the liver, and proved to be small glassy ova with opaque white internal markings. They were found in every specimen examined, and in well marked cases they occurred in hundreds, crowded together like clusters of grapes. The egg case was very tough and contained a living embryo which has a gentle gliding movement in the egg. It lies in a double or coiled position, and after extension crawls about with an undulating motion like a Planaria. At the upper end is a circular oval sucker, from which an œsophagus proceeds downwards dilating into an ovoid sac, and again contracting, passes down the middle of the body, and finally divides into two wide alimentary cæca, forking outward to the sides of the body. These ova, which occur in nearly every soft texture in the interior, except perhaps the heart, appeared to be nearly of the same age in every specimen; in all probability they attain little more development in the body of the crab, but await the ingestion and digestion of the Crustacea by such fishes as the Cotti, Gadi, and others, in whose stomachs they become complete Distomas. In two cases also an Ascaris was found amongst masses of liver removed from a Carcinus, and possibly swallowed with fragments of a fish.

Mr. Gosse describes in the 'Annals of Natural History' a new genus of Sea Anemones, which he says might well put in a claim to be considered Pulcherrima, if we had but a Paris to judge. The animal, which he has named Ægeon Alfordi, was discovered by the Rev. D. P. Alford, Chaplain of the Scilly Isles, in March last, under a large stone, from under which the tentacles were protruding like those of an Anthea. But on removing the stone he found an Anemone with high standing column, like an Aiptasia, but with the surface warted, and with tentacles like the richest green velvet, throwing into the shade the brightest of Antheas. This species Mr. Gosse finds to possess very obvious affinities to both Aiptasia and Anthea, but the character of the column distinguishes it well from either, and he has constituted for it the new genus, Ægeon. After very many protracted watchings with a powerful lens, when the body was in the most favourable condition for observation, he could never discern the slightest trace of *cinclides ;* nor has any amount of provocation produced the emission of *acontia.* At present this is a unique specimen, but it is hoped others may be found. The Scilly Islands appear to abound with Aiptasiæ—other species and varieties are well represented—but among the rocks of Port Crassa Bay the Aiptasiæ are far more common than the Actinia mesembryanthemum.

Professor Bell communicates to the 'Zoologist' an account of a very severe injury done by a *Physalis,* or Portuguese Man-of-war, at

St. Vincent. A person bathing was seized by the long arms of this Acaleph, which wound its twining thongs completely round his body and instantly benumbed him. He would have been drowned had not a companion with him pulled him out of the water: but it was some hours before any hope was entertained of his recovery; his flesh was then twitching frightfully, and his body covered with wheals the size of one's finger, as if he had been beaten with thick cords.

X. SCIENCE IN BRAZIL.

In the Chronicle of Zoology of the last number of this Journal, we announced that Professor Agassiz and a party had left New York on the way to South America, on an exploring expedition, his chief object being to make extensive collections in zoology, and observations in other natural sciences. The expenses of the expedition are, as we stated, defrayed by Mr. Thayer, a liberal citizen of Boston.

Professor Agassiz arrived at Rio Janeiro, and leaving behind him a memento of his presence, has passed onwards to the Amazons. His progress so far has been chronicled by an excellent little journal called 'The Anglo-Brazilian Times,' and a copy of that journal (dated July 8th) having been forwarded to us, we extract from it for the perusal of our readers the following interesting account of services rendered to science by Professor Agassiz during his sojourn in Rio:—

"In the midst of so much of the conflicting elements of war, with the news of victory scarcely subsiding into calm before other reports of defeat and disaster come to distress the public mind, and to kindle, let us hope, in all hearts a yet stronger spirit of national enthusiasm, we as journalists have to note that, side by side, the desolation of war is accompanied by the peaceful spirit of scientific investigation. Professor Agassiz has for a time suspended his operations in this part of the empire, and is going with his staff to explore the district watered by the Amazon.

"Our readers will be aware that since the illustrious stranger arrived in Rio he has not been for a moment at rest. Whilst his assistants have been each in his special department working towards the attainment of the object which they have in view in Tropical America, the Professor himself has been the most active of the party, trying to win from nature the secrets which she holds, and we are informed that many new and interesting facts have been added to the domain of science. Apart from the collection of these facts, and from expeditions in and about the Province of Rio de Janeiro, the Professor has given us opportunities of hearing him explain his theory of erratic boulders, and all who have heard him have been struck with the ease by which the dry bones of a scientific fact can be made replete with interest when handled with simple grace by a clear and comprehensive intellect. The illustrious teacher is, as we have said, going for a time from the capital, let us be assured only to return to it laden with treasures which will, under his powerful exposition, teem with interest for scientific men in all quarters of the globe, and which for the country we are in will have a very direct and special importance.

"We have from the outset looked upon this expedition with great

interest, in so far as we have seen in it a value lying without the fields of pure science. The speculations of the philosopher of to-day may to-morrow become the established facts of commerce, and it will be impossible for the investigations of Agassiz to leave behind them only barren results. His labours may in the end yield us a harvest of material wealth; indeed, we have before us at this moment one very pertinent illustration of this fact, which we may assume is but the forerunner of many others of a kindred kind.

"Our readers have for a long time heard of the famous coal beds of Candiota, in the Province of Rio Grande do Sul. The expectations of many are turned in that direction, as the most valued instance of the hidden wealth of Brazil. Mr. Plant has so far awakened or revived an interest in these things that from time to time the topic has been made a public one, has been looked at as a field for commercial activity, and has been debated each time with growing interest in the legislature. We are not to-day talking of the value of this matter in the abstract, our minds have long been made up upon that question; we only wish to show how the opinion of a man like Agassiz at once settles the whole question, and leaves only to commerce the practical development of plans for making available this most important element in a nation's wealth and power.

"Mr. Plant, as a geologist, submitted to the examination of the Professor such fossils and geological illustrations of the Province of Rio Grande do Sul as he supposed would be of interest, and would help to complete the collections which are being made for the United States Government. The importance of these fossils and the sure deductions which science draws from them appear to have startled and delighted the great *savant;* and a few days since the following letter was placed in the hands of Mr. Plant. We print it *verbatim*, as it is of such a nature as to become at once important, and will show the Government of Brazil that if it only follows up the path opened up by science the results as a source of wealth cannot be doubted.

"'*Rio, June* 18, 1865.

"'Dear Sir,—I have not yet returned my thanks for the fine specimens you have presented to me, though ever since I saw them I have looked for a moment's leisure to do so.

"'However, this gives me an opportunity of expressing a more mature opinion concerning their geological age, which I am glad to have an opportunity of recording, especially since the examination I have made of them has satisfied me of the correctness of some views concerning the fossils of the oldest geological formation, in which I had little confidence. That these organic remains all belong to the carboniferous period is unquestionable, and it is the close affinity with the characteristic fossils of Europe which particularly interests, and in a measure surprises me. Had the whole collection been made in Pennsylvania, I would not more decidedly have recognized its carboniferous characteristics, down to the rocks underlying and overlying the fossiliferous beds; and the photographs you have shown me of the localities leave no doubt of the great extent and value of the coal-beds proper of the river Candiota, whilst the coal itself may fairly be compared to the best in the market, judging from the specimens you have shown me, and those I owe to your kindness.

"'As to the coal of the Falkland Islands, I can only compare it to the Anthracite of Mansfield in Massachusetts, and the adjoining deposits in Rhode Island; though it does not appear quite so pure as the best Anthracite of the United States; but this is an impression derived from surface specimens, gathered at random.

"'With my best wishes for the further success of your geological explorations, in which I hope you may hereafter also include the drift and erratics, now that you are satisfied of their existence in Brazil,

"'I remain yours very truly,

"'*N. Plant, Esq.*' "'L. Agassiz.

"We think our subscribers will join with us in our opinion that we have much to look for from this expedition fitted out by the munificence of a Boston merchant. It may be that with a conviction of the value of science as an agent in commerce this expedition has been projected. We are sure the indirect results will, for Brazil, be very important. One of the world's greatest *savans* is breaking in upon a region almost unknown. His aim is, we know, to extend the empire of mind and to storm the strongholds of nature, making her subservient to the wants of man, and in parting with Professor Agassiz and his co-labourers for a season, we can but give him our benediction with the hope that in a few months he will be amongst us again rich with treasures from the Amazon, and that before he leaves Brazil for his adopted home he may be able to delight us with a course of lectures specially illustrative of his investigations in the land of the Southern Cross, and of the treasures which are lying waiting to be made useful by the energy of man.

"(1) We point to the latter portion of this very important letter of Professor Agassiz as a provisional answer to the assertion made by the medical officer of H. M. S. Stromboli 'to the effect that coal does not exist on the Falkland Islands.' The question is a scientific one, and the Great Philosopher from Cambridge, U. S., has by geological deduction, as we have seen, declared in favour of the position assumed by Mr. Ramsay Cooke, of H. M. S. 'Egmont,' who was the first discoverer of these coal-beds, and who assures us that the coal from these deposits was burned by H. M. S. 'Satellite,' on her passage from the Falkland Islands to Rio.

"(2) We are also at liberty to state, that Sr. Capanema, whose abilities as a geologist are too well known to need comment, has also seen Mr. Plant's collection of fossils from the Candiota coal-mines, and has arrived at the same conclusion as Professor Agassiz in respect to the coal-beds belonging to the carboniferous period, a fact which the illustrious Sr. Capanema had hitherto doubted."

XI. SCIENCE TEACHERS' ASSOCIATION.

In an article on "The Science and Art Department" in the January number of this Journal, a suggestion was made that the teachers of Government Science Classes should form themselves into an association for the protection of their mutual interests. We are glad to find that it has had the effect of leading to the formation of a union. Meetings of Science teachers were held in Birmingham on the 8th and 12th of September (during the Meeting of the British Association), for the purpose of considering the question. The feeling in favour of forming a united body was shown to be very general; a considerable number of teachers who could not be present expressing their concurrence by letter, generally in very warm terms. At the meetings referred to it was resolved to form a body, to be called 'The Association of Certificated Science Teachers,' and to be open to all those teachers who are certificated in Science by the Department of Science and Art. Its objects were defined to be the furtherance of Science instruction in connection with the system of the Department of Science and Art, the advancement of Science teaching as a profession, and the mutual interchange of ideas and information. The business of the Association will be conducted by a Council, consisting of a President, a Secretary, a

Treasurer, and nine other members, to be elected annually. The President, Secretary, and Treasurer constitute a Sub-committee for the consideration of all communications addressed to them by members on matters connected with the objects of the Association: and, when necessary, the subject of any such communications will be referred to the Council or to the general body of members for further action. In this way, each Science teacher will have the opportunity of bringing under notice any information, suggestion, or difficulty; and whenever the importance of the case demands, the Council will proceed to ascertain the opinion of the whole body of teachers thereon, or to recommend joint action if necessary. A subscription of five shillings per annum is expected to cover all expenses, and at the same time to be not more than will be readily subscribed by Science teachers. A general meeting is to be held annually in the month of July, in some town conveniently situated; at which meeting the reports of the Secretary and Treasurer will be received, the officers elected, and all business transacted and subjects discussed which have been considered and approved by the Council. Members wishing to bring forward matters for discussion must give due notice to the Secretary. It is considered that by these arrangements all suggestions will receive due consideration, whilst all subjects of general interest will be brought before the whole body of teachers.

At the meeting of the 12th September, a code of rules embodying the above points was considered and adopted. The Council for the ensuing year was elected; Dr. E. H. Birkenhead, of the Wigan Mining School, being appointed president; Mr. John Jones, of Dudley, treasurer; and Mr. John Mayer, of Glasgow, secretary. It was decided to hold the first annual meeting at Liverpool, in July next.

REVIEWS.

RADIATION.*

A not very enlightened sceptic once remarked that he doubted "whether there was any other God but motion." Had he not ignorantly mistaken effect for cause, and if he had, instead, uttered a doubt whether there was any physical *force* other than motion, he would have been nearer the truth, and would have expressed the view of the most advanced thinkers of our time. For every day it is becoming more apparent that the various forces or phenomena known to us as Heat, Light, Electricity, &c., all result from the more or less rapid motion of matter in a more or less attenuated form. Thus, when we hear of light travelling at the rate of 192,000 miles per second, reaching our earth in about eight minutes after it has left the sun, we are not to suppose that any special force is being employed, differing from that which conveys the sensation of heat from a body of elevated temperature to our persons, or from that which causes the air, agitated by the vibrations of a sonorous substance, to strike against the tympanic membrane of the ear, and produce the impression of sound. All these manifestations, light, heat, and sound, are believed to be simply the effects of the more or less rapid vibrations of atoms of matter variously grouped, communicated to organs of the body differently constituted to receive those divers impressions.

When any hard substance is submitted to violent friction, heat, sound, and perhaps electricity, may be the result of the motion of its molecules. In the case of sound being produced, the atoms of the resonant substance first begin to vibrate, then they impart motion to the molecules of the circumambient air, and this being agitated in waves reaches the tympanic membrane, and there produces the effect which we know as "sound," an effect which is passed onwards through the complicated structure of the ear and the auditory nerve to the brain, whereby the mind is rendered conscious of its existence. A similar motion of particles, conveyed with or without the medium of the air, to the nerves of touch, causes the phenomenon of heat, which may be communicated to the brain and be thus rendered conscious, or it may be arrested at the surface of the body, and affect only the

* 'On Radiation.' The Rede Lecture delivered in the Senate House, before the University of Cambridge, on Tuesday, May 16th, 1865. By John Tyndall, F.R.S., Professor of Natural Philosophy in the Royal Institution, and in the Royal School of Mines. London: Longmans.

'The Phenomena of Radiation, as Exemplifying the Wisdom and Beneficence of God.' (Actonian Prize Essay.) By George Warington, F.C.S. London: William Skeffington.

'Heat Considered as a Mode of Motion.' By John Tyndall, F.R.S., &c. Second Edition, with Additions and Illustrations. London: Longmans.

muscular system by what is called "reflex action." But should the friction of the hard substance be sufficiently protracted and violent, or if the substance itself be peculiarly susceptible (as in the case of phosphorus), a third effect follows upon the production of heat, namely luminosity, or the emission or radiation of light. This effect of the motion of matter is conveyed to the optic nerve, and thence to the brain, even where no atmosphere intervenes, and the medium of communication is believed to be the "luminiferous æther" which is supposed to pervade all space.*

Thus it will be observed that the friction of some particular form of matter may give rise to what are regarded as three distinct phenomena—sound, heat, and light; the first being sound, then, as the vibration of its atoms become more rapid, heat, and finally, when the temperature has been sufficiently raised, light is the result.† But this may be merely an outline of the successive phenomena arising from simple application of mechanical force to matter and the vibration of its atoms. In the case of sound, the tone emitted may rise in intensity, changing its quality as the vibrations become more rapid, and the effect of a musical scale may be produced; and in like manner the rays of light emitted may, as the radiation becomes more rapid, not only change their character to the appreciable sense, rising in the scale of colour, to use a familiar expression, and perhaps producing what to some organs of vision differing from ours, may form parts of a chromatic or colour scale divisible into octaves,‡ but they may even act as distinct forces, some with chemical effect, others with illuminating, and others again with thermic influences. Let us now, instead of considering the phenomena attendant upon the heating of a substance by friction, select an example, where the heat is the result of electricity, and we shall be enabled to obtain a very clear picture of the effects just named.

"If a current of electricity of gradually increasing strength be sent through a wire of the refractory metal platinum, the wire first becomes sensibly warm to the touch; for a time its heat augments, still, however, remaining obscure; at length we can no longer touch the metal with impunity, and at a certain definite temperature it emits a feeble red light. As the current augments in power, the light augments in brilliancy, until finally the wire appears of a dazzling white. The light which it now emits is similar to that of the sun."§

And if the light thus emitted be analyzed by means of a prism, as it increases in brilliancy it is found "that when the platinum wire first begins to glow the light emitted is a pure red. As the glow augments the red becomes more brilliant, but at the same time orange rays are added to the emission. Augmenting the temperature still

* 'Radiation' (Tyndall), p. 18.

† In the case of glass or sealing-wax, we have sound, heat, and magnetism or electricity.

‡ See note on the "Probable Existence of the Repetition of Octaves in the Solar Spectrum," by C. Hilton Fagge, M.D., 'Quarterly Journal of Science,' No. v., p. 182.

§ 'Radiation' (Tyndall), pp. 2, 3.

further, yellow rays appear beside the orange, after the yellow, green rays are emitted, and after the green come in succession blue, indigo, and violet rays. To display all these colours at the same time the platinum wire must be *white hot*, the impression of whiteness being in fact produced by the simultaneous action of all these colours on the optic nerve."*

It has already been stated, and is no doubt well known to our readers, that these variously-coloured rays possess different properties, thus, the undulations which reach the eye, as orange or red rays, possess specially a heating property, the yellow, an illuminating power, and the blue or violet an actinic or chemical influence, and in the white or colourless light of the sun we have these three properties perfectly combined, for the complete fulfilment of the ends of nature. If, then, we glance hastily over the whole series of phenomena of radiation, we find that physically they take their origin in the motion of matter. Whilst the nature of the substances, or form of matter acted upon, is diversified in the extreme, the force in operation, or the mode of motion seems to be uniform; at least it appears to vary only in the speed with which the atoms or molecules are agitated. But the results, as conveyed through the organs of sense to the brain, are incalculably diversified; sounds which charm the ear or soothe the soul; others that fill the mind with terror; various degrees of heat, from the gentle warmth of the morning sun, to the glowing metal from the furnace; and light of all hues and tints, direct and colourless, or partially resolved into its original elements, by reflection from the pansy or the rose, or from the verdant carpet of the pastures; each affects with its power to minister to life or modify the character of nature's forms or forces.

The ascription of these phenomena to so simple a cause as the motion of matter, known as radiation, is not the result of speculation only; for much is already known concerning the rapidity with which the atmosphere and the presumed luminiferous æther (or whatever may be the medium through which light is transmitted) are set in motion. It is well established that a sonorous wave moves at the rate of 1,100 feet per second, or rather that the impression of sound is conveyed to the ear at that rate; also, that a ray of colourless light is projected through the ether, at the speed of 192,000 miles in a second; that if such a ray be resolved into its constituent elements as exhibited by the prism, red light travels more slowly than orange, orange than yellow, and so on to the violet, whilst at either end of the spectrum there are "non-luminous rays" which move either too slowly or too rapidly to produce any effect upon the human retina.

These non-luminous rays although invisible to us have still very marked properties; those beyond the red end of the spectrum possessing great heating power, whilst those at the other extreme are endowed with considerable actinic properties; indeed Dr. Tyndall has shown that as far as the electric light is concerned by far its

* 'Loc. Cit.', p. 3 (Dr. Draper's experiment).

greater heating power is exercised at a considerable distance beyond the red, or thermal end of its spectrum.* When we add that it is even estimated, in round numbers, at what rate each of these rays is projected,† it is not unreasonable to believe that the chief, if not the sole cause of the varied phenomena, known to us as light, heat, &c., are all varieties of the same force; namely, the simple motion or radiation of matter, and it remains for physicists to pursue their inquiries into the behaviour of various forms of matter in an uncombined or combined state.

In this department of research, also, much has been effected, and Dr. Tyndall's work on "Heat Considered as a Mode of Motion," comprises an admirable *résumé* of almost everything that is known on the subject. It treats of the deportment of the various gases, liquids and vapours, of the metals, woods, simple bodies such as iodine, bromine, &c., and of the effect of radiation upon compound substances, as lamp-black, &c.; and describes many novel and original experiments bearing on the subject. His second work on "Radiation," however, brief though it be, possesses far greater interest for scientific men, for it deals largely with the question of radiation in "æther," air, vapours, perfumes, &c.; and reveals many startling novelties concerning the influence of matter in a diffused form upon the passage of heat. Let us extract a single series of experiments:—

"*Absorption of radiant heat by vapours and odours.* We commenced the demonstrations brought forward in this lecture by experiments on permanent gases, and we have now to turn our attention to the vapours of volatile liquids. Here, as in the case of the gases, vast differences have been proved to exist between various kinds of molecules, as regards their power of intercepting the calorific waves. While some vapours allow the waves a comparatively free passage, in other cases the minutest bubble of vapours, introduced into the tube already employed for gases, causes a deflection of the magnetic needle.‡ Assuming the absorption effected by air at a pressure of one atmosphere to be unity, the following are the absorptions effected by a series of vapours at a pressure of $\frac{1}{60}$th of an atmosphere:—

Name of vapour.	Absorption.
Bisulphide of carbon	47
Iodide of methyl	115
Benzol	136
Amylene	321
Sulphuric ether	440
Formic ether	548
Acetic ether	612

"Bisulphide of carbon is the most transparent vapour in this list; and acetic ether the most opaque; $\frac{1}{60}$ of an atmosphere of the former,

* Tyndall, pp. 23 and 24, and Frontispiece.

† The extreme red rays making 474,000,000,000,000 vibrations in a second, and the extreme violet 699,000,000,000,000.

‡ The "tube" and "magnetic needle," here mentioned, are instruments which will be found described in "Heat considered as a mode of motion."

however, produces 47 times the effect of a whole atmosphere of air, while $\frac{1}{60}$ of an atmosphere of the latter produces 612 times the effect of a whole atmosphere of air. Reducing dry air to the pressure of the acetic ether here employed, and comparing them then together, the quantity of wave motion intercepted by the latter would be many thousand times that intercepted by the air.

"Any one of these vapours discharged in the free atmosphere in front of a body emitting obscure rays, intercepts more or less of the radiation. A similar effect is produced by perfumes diffused in the air, though their attenuation is known to be almost infinite. Carrying, for example, a current of dry air over bibulous paper moistened by patchouli, the scent taken up by the current absorbs thirty times the quantity of heat intercepted by the air which carries it, and yet patchouli acts more feebly on radiant heat than any other perfume yet examined. Here follow the results obtained with various essential oils, the odour in each case being carried by a current of dry air into the tube already employed for gases and vapours:—

Name of Perfume.	Absorption.
Patchouli	30
Sandalwood	32
Geranium	33
Oil of cloves	34
Otto of roses	37
Bergamot	44
Neroli	47
Lavender	60
Lemon	65
Portugal	67
Thyme	68
Rosemary	74
Oil of laurel	80
Camomile flowers	87
Cassia	109
Spikenard	355
Aniseed	372

Thus the absorption by a tube full of dry air being 1, that of the odour of patchouli diffused in it is 30; that of lavender 60, that of rosemary 74, whilst that of aniseed amounts to 372. It would be idle to speculate on the quantities of matter concerned in these actions."

It would be impossible, in a short notice such as the present, to refer to the numerous and interesting results that have been obtained by experimenting upon the passage of heat through the atmosphere, or *in vacuo*. Dr. Tyndall has tested the absorbing and analyzing powers of numerous substances, and in some cases has applied his experiments to practical ends, or at least he has indicated channels in which they may be practically employed. Thus he has tested, physically and chemically, the percentage of carbonic acid in the human breath, and when we remember what startling and unexpected results have recently been obtained by means of spectrum-analysis; how, for example, blood has been traced in fabrics long after the tell-tale fluid was spilt upon them, we cannot but watch with interest, researches which have a direct bearing upon physiological and sanitary science.

But there are even higher and more important benefits likely to accrue to the human race from such scientific studies as these, however valuable they may be in a material sense. The information which is pouring in upon us day by day concerning the subtle forces of nature and the properties of matter tends to develop the intellect, to exercise the reasoning faculties, and to substitute for unreasoning credulity and superstition a rational and ever-expanding conception of the Creator.

It is to the task of thus interpreting the recent revelations of Science that Mr. Warington has applied himself; and most deservedly has his noble work been rewarded by the bestowal of the Actonian Prize; a premium which the goodness of a lady has bequeathed for the encouragement of a reverential study of Science. With this view the author has not contented himself with treating of the phenomena of radiation only in as far as they are to be observed in the inorganic world, but he has shown how admirably the laws of motion here referred to were framed for the advent of organized beings.

Although the discussion of vital forces can hardly be considered to come within the scope of the subject treated, yet we can easily conceive that in his reflections upon the influence of radiation the author would be drawn into those indirect results, or rather accompaniments, of the operation of physical forces, and it would be almost as anomalous to overlook the presence of plants and animals, in their relation to heat, light, &c., as it would be to give the geography of a country and omit to make mention of its inhabitants. Thus he does not confine his observations to the method in which the forces operate, nor limit his field of inquiry to the inorganic world; but he shows how all these, the meteorological, geological, and astronomical changes bear upon the life of plants and animals. Nor does he for a moment appear to lose sight of the main object of his essay. Whilst it is free from anything like cant, and presents no approach to that spirit of intolerance which would dictate to the students of science in what theological Shibboleth they must seek their axioms, it is one fresh, joyous pæan of praise to the Creator, expressed, as far as man is able to do so, in suitable poetical language.

In every dewdrop, in every cloud, in each ray of sunshine, in every gentle gale that blows, he sees, and sees rightly, a fresh evidence of the " wisdom and beneficence of God." But we will let him speak for himself, selecting a somewhat lengthy extract from his work to show how ably it is penned :—

"But yet, again, the *kind* of radiant force the sun gives forth is beautifully accordant with the work it has to do. The mighty operations of its beams that have engaged our attention hitherto are all accomplished by *one* section only of the rays composing them—the heating rays: almost wholly by those invisible to the eye, the extra-red. Some few of the more highly refrangible rays are changed, indeed, by absorption, and so become effective; but the proportion done by these is scarcely worth notice. It is to the originally obscure heat rays of the solar spectrum that winds and rains and currents owe their origin. These rays, as before noticed, are those which lower temperature occasions, merely rising in intensity and number with the development of quicker undulations. They are hence

just those which of necessity must be most numerous and powerful in such a mixed radiation as the sun's. Had the case been otherwise—had we depended exclusively upon the visible solar rays for climate—had these been heating and those luminous—our earth would have been in sorry plight; they have not intensity of power equal to such needs. Yet can Science tell us why such minute differences in the length of waves of motion should confer such different powers? She can but say they do. And as their doing so is manifestly necessary to the maintenance of Nature's order, the fulfilment of her ends—plainly, too, adjusted to the properties and forms of matter they affect—Religion claims them for her own, and says God made them so.

"Standing at this height, then, and regarding every part of this vast system of causes and conditions as coming straight from God, how marvellous a picture of His mind and attributes does it present. Before yet any force or matter existed, He was planning out their nature and relationships, determining the absolute quantity and form of each, bestowing properties and powers, ordaining laws, parting each several kind to its predestined place and office, allotting to each its own peculiar work, yet causing all to aid and help the others; disposing with like ease and skill the mightiest and minutest agents, the causes and conditions of each varied action; adjusting link to link in complex order, each influencing and modifying the rest, yet all together subserving one great purpose, and so subserving it as if it were their purpose too, as if they too desired their Creator's ends; watching and guiding all from age to age, developing and perfecting the scheme by gradual elaboration, until at last it reached its present form and symmetry, its beauty of proportion, its meetness for its end. Such wondrous harmony in Nature's working, such seeming will and purpose, might almost make one think there was a life, a mind, in things inanimate. Yet no; these are but the robes, the outward dress of Deity, bearing the impress of their Maker truly, but of themselves incapable of aught; they are but instruments to work His will—perfect instruments, because made and adapted for that very end, and wielded by the All-wise hand that made them—yet still but instruments. Man compares his instruments and machines with this, and how immeasurably inferior now do they appear; how crude, how clumsy. How vast—how infinitely vast—the distance that separates the Creator's mind and wisdom from the man's!"

Besides its higher merit, Mr. Warington's little work possesses that of being educational, for it comprises a popular *résumé* of all that is generally known in regard to the operation of the physical forces in nature; and it is a book which we would especially recommend to teachers of youth, inasmuch as it is calculated to impress the latter with the value of such knowledge more effectively than a mere handbook of physics.

There are some expressions in it which we have either not clearly understood, or they are at variance with the general views enunciated by the author. Are we to understand that the "sun's surface particles" are themselves "shot hither through thirty million leagues of fine intangible æther," or merely that their "delicate tremor" * in the sun's surface is communicated to our atmosphere through the wavelike agitation of the "fine and intangible æther diffused throughout all space and throughout all matter?"†

* P. 102. † P. 24.

It appears to us that these two cases precisely represent the difference between the exploded view that heat is matter, and the one which regards it as the mode in which matter is moved; either the author is wrong in his science, or there is a want of clearness in his diction which we have noticed elsewhere in the work.

This does not, however, detract in any material degree from the merit of a beautiful and edifying scientific essay, to which, as well as to Dr. Tyndall's treatise, we desire to accord all honour and praise.

THE SCENERY OF SCOTLAND.*

With the exception of Scandinavia, there is no country in Northern Europe whose physical features more boldly challenge the investigation of students of nature than Scotland. Geographers, whose province often extends only to the outline and surface, have never failed to point out the striking contrast of its eastern and western shores, attributing the more deeply indented margin of the latter to the fierce assaults it has experienced from the Atlantic breakers, forgetting, however, that many of its deepest bays and fiords stretch inland at right angles to the direction of the waves, and can, therefore, in no way be attributable to their action. Nor has the surface of the country attracted less attention than its outline. The stern and wild region of the Highlands, divided by the deep channel of the Caledonian Canal; the lofty rampart of the Grampians ranging from sea to sea across the island, and forming the physical boundary of the Lowlands; the broad undulating valley of central Scotland, stretching southwards from the base of the Grampians, and deeply indented on both sides by the Firths of Clyde and Forth, and bounded on the south by "The Southern Uplands," as they are termed by the author, —a region of high swelling moorlands and narrow valleys, neither so lofty nor bold as the Highlands, yet attaining in Merrick an elevation of 2,764 feet.

Mr. Geikie enters upon the task of expounding the physical changes which have resulted in the scenery of Scotland with all the enthusiastic love and admiration which every Scot bears his native land, and to which Scotland's great poet gave such memorable expression—

> "Land of my Sires! What mortal hand
> Can ere dissolve the filial band
> That knits me to thy rugged strand?"

while he is at the same time thoroughly imbued with the more "advanced" theories on the subject of atmospheric denudation and glacial erosion. The author is also a warm supporter of Professor Ramsay's theory of the glacial origin of lakes, and, with many of the younger geologists, he maintains the sufficiency of frost, snow, and ice,

* 'The Scenery of Scotland, viewed in connection with its Physical Geology.' By Archibald Geikie, F.R.S. Macmillan & Co.

rains, torrents, and rivers, to channel out the valleys of mountainous regions. "Only give me time," he says, in so many words, "and I can remove mountains." Nor is it necessary to remind our readers that the geologist takes as much time as he pleases whether it is given to him or not.

The earlier pages of Mr. Geikie's work contain an interesting account of the rapid waste which the eastern coast of Scotland has undergone within historic times. Along some parts this waste is alarmingly rapid. Villages, churches, castles, farms, of whose former existence there is historic record, have disappeared before the ceaseless attacks of the waves, so that, contrary to the popular notion, this coast is wearing away with much greater rapidity than the western. The process of decay is also facilitated by the generally softer nature of the rocks on the eastern coast, a considerable length of which is formed of Old Red Sandstone. On the western side, the parts which are most frequently exposed to the attacks of the Atlantic breakers, are composed of tough gneissose or slaty rocks, admirably adapted for resisting disintegration, while the long chain of the Hebrides, stretching athwart the coast, acts in some degree as a natural breakwater to the mainland.

Mr. Geikie divides the surface of the country into three physically distinct regions—the Highlands, the Central Valley, and the Southern Uplands—each of which he treats of separately. He considers that about the commencement of the period of the Old Red Sandstone the highlands began to appear from below the sea in the form of an undulating plain with occasional prominences. This was "a plain of marine denudation." Thus far the author only recapitulates the views of Murchison, Sedgwick, Nicol, and other geologists. But now arises the question, How, out of such a plain, were the mountains and valleys formed? Was it by the upheaval of some special lines and the depression of others, assisted by the action of the waves and currents as the land continued to rise above the level of the sea? Or, on the other hand, has the result been brought about by atmospheric agencies? Now, while admitting that the occasional displacements of the strata by faults, and minor elevations and subsidences, may have had some slight effect in originating lines of hill and valley, and also that the sea had its due influence, the author regards the atmospheric agencies as by far the most powerful. To the former view there is this serious objection—that the action of the sea tends invariably to level all opposing barriers, and to reduce the surface to one nearly uniform plain. Nor is it conceivable that the sea could produce valleys of the kind which occur in the Western Highlands, or the firths and sea-lochs which pierce the coast all along its margin from Cape Wrath to the Clyde. A glance at a well-shaded map (such as that which accompanies this volume) will serve to show that the sea-lochs are generally continuous with the valleys or glens of the land, and that they are to be considered only in the light of submerged valleys. In proof of this Mr. Geikie adduces what to our mind seems conclusive evidence in the fact, that they contain in some places "rock-basins."

In seeking, then, for a cause sufficient to account for the scenery of

glaciers which once overspread the whole of the lower grounds, as in Greenland at the present day; the newer which shows rude traces of the Highlands, we are forced to leave the ocean and take to the land; and here we see agencies actually in operation, either in this or other lands, which in the author's opinion are fully calculated to produce, when acting throughout incalculable ages, that striking variety of mountain and fell, glen and loch, which, when once seen, leaves an impress on the mind never to be effaced.

Let us now follow the author in his view of the manner in which all this has been brought about.

Starting with the assumption that the Highlands were raised from the ocean in the form of a plain or table-land, with a few points or lines slightly outstepping the surrounding areas, he supposes that this plain would at once be subjected to atmospheric influences. Rain falling on its surface would form itself into rills, which, uniting into brooks, would then find their easiest way into the sea. A channel once formed, however shallow, would go on increasing in width and depth, and as the land continued to rise, and the action of frost, rain, and stream combined in the work of scooping out and carrying away solid matter, valleys would ultimately be formed, and if valleys, mountains; because mountains of the kind of those in Scotland, Wales, and Norway, may be looked upon with much probability as portions of ancient table-lands, out of which the valleys have been scooped.

We have thus given a short outline of the views of the author without going into details, which space forbids. For ourselves we are disposed to go a long way in support of them; though, perhaps, not to the extent of the author himself. That rivers, and even mountain torrents have the power of scooping out channels and valleys of considerable depth and width is unquestionable; but where the valleys are wide, with very slightly shelving sides which bear no traces of river erosion, but on the other hand preserve the smooth and uniform contour which is presumably the effect of marine denudation, we are at a loss to conceive on what grounds atmospheric agency can be called in here. The case is also strengthened if we find marine stratified deposits of the Drift period occupying such flats, as is often the case. That these main valleys were formed before the Drift period may be perfectly true, but we base our argument in opposition to the view of progressive atmospheric waste in *such* instances, on the presence, after so long a period, of these marine deposits.

In truth, the term "valley" is unfortunately vague, as in many instances one main valley may include several minor ones, and while these latter may owe their origin to one class of agencies, the former may be due to another class. Thus, the greater may be of marine growth, the lesser of fluviatile. A considerable portion of Mr. Geikie's book is necessarily devoted to the description of the glacial phenomena of Scotland in relation to its aspect, and the origin of its lochs, lochans, and sea-lochs or fiords. In this field there have been many fellow-workers; amongst whom Chambers, Nicol, and Jamieson hold a prominent place. He considers that there are two very distinct kinds of boulder clay: the older being unstratified and due to

bedding, having been deposited by the sea during a subsequent partial submergence. The rock-basins, both those now under the sea and inland, he unhesitatingly attributes to the scooping power of land ice, as well as the generally rounded form of the lesser hills, and those of the Southern Uplands of the Borders.

The work is accompanied by a very beautifully executed geological map of Scotland, published originally by the author conjointly with Sir R. Murchison, but embracing all improvements up to the present time; and we can only say in conclusion, that whether or not we agree in every point with the author, we have no hesitation in admitting the ability with which the subject is treated, and the rich store of observations on the physical geology of Scotland which the book contains.

SATURN AND ITS SYSTEM.*

When the peculiarity and beauty of the Saturnian system are considered, it cannot be surprising that it has attracted much attention and been the subject of many speculations. Even before the invention of the telescope it is probable that a peculiarity of configuration, due to the presence of the rings, had been recognized by the ancient astronomers, who surveyed the heavens from the elevated plains of Asia. For in a letter written some years ago to Sir J. Herschel, by the Rev. Mr. Stoddart, from those very plains (from Oroomiah, in Persia), the following suggestive passage occurs :—"It is not too much to say that, were it not for the interference of the moon, we should have seventy-five nights in the three summer months superior for purposes of observation to the very finest nights which favour the astronomer in the New World.† I was very curious to know whether any traces of Saturn's ring could be discovered. To my surprise and delight, the moment I fixed my eyes upon it steadily the elongation was very apparent. . . . Several of my associates, whose attention I have since called to the planet, at once told me in which direction the longer axis of the ring lay, and that too without any previous knowledge of its position or acquaintance with each other's opinion." The extraordinary clearness of the eastern atmosphere may perhaps serve to explain a curious statement in 'The Phenomena' of Aratus, written about 240 B.C., *viz.* that men say, and poets pretend, that one of the planets has passed away. Whence it seems probable that the people from whom the Greeks derived their astronomical system could distinguish one planet

* 'Saturn and its System: containing Discussions of the Motions (real and apparent) and Telescopic Appearance of the Planet Saturn, its Satellites and Rings; the Nature of the Rings; the "great inequality" of Saturn and Jupiter; and the Habitability of Saturn. To which is appended Notes on Chaldæan Astronomy, La Place's Nebular Theory, and the Habitability of the Moon; a Series of Tables, with Explanatory Notes, and Explanations of Astronomical Terms.' By Richard A. Proctor, B.A., late Scholar of St. John's College, Cambridge, and King's College, London. London: Longman & Co.

† Mr. Stoddart was an American, and had observed in many parts of the world with efficient instruments of his own construction.

more than was discernible from Greece. This people, as we shall have occasion to point out further on, was most likely the Assyrian; and the fact quoted above from Mr. Stoddart renders it possible that they might have guessed at the true structure of the Saturnian system, and precludes the necessity of our resorting to the author's conjectures, that the rings in early times were of much larger size than at present, and therefore easier of detection, or that telescopes as powerful as Galileo's were then in use. If, however, the knowledge of this system ever did exist it must have been lost in the lapse of time, for in none of the ancient astronomical writings, so far as we know, is it alluded to. To mention only one: Hyginus, the general bent of whose studies and whose position as librarian at Mount Palatine must have made him accurately acquainted with the opinions of more ancient writers, is silent concerning it. In the 'Poeticon Astronomicon' the planet is briefly described as of great size, and of a yellow hue, and as being "similis ejus stellæ, quæ est in humero Orionis dextro."

But though, like all other physical sciences, astronomy has been greatly progressing, and that especially during the past two centuries, yet it would be altogether unjust to think lightly of the results obtained by the old philosophers, because their most powerful instruments were their eyes, because they were ignorant of logarithms and fluxions, or because they supposed the stars to influence human destinies. Mr. Proctor has done well, therefore, we think, to carry us back in imagination to primitive times, and thence to lead us step by step over the ground trodden by the contemplative men of the East, until they attained to the loftiest and possibly the justest conceptions of the grandeur, extent, and beauty of the universe. In his own words, "the time thus spent would not be altogether wasted if we only learnt thence lessons of patience and watchfulness." The method of teaching astronomy by first discarding all the appliances and aids which modern ingenuity has devised, and directing the pupil's unaided gaze to the view presented by the sky on a starry night, is altogether a novel one, but is as useful as it is novel, and is, moreover, as natural as it is useful, for not one in a hundred, perhaps, enjoys the advantages of telescopic aid till long after he has begun to watch and reflect on the strangeness of the planets' apparent motions. Placing the reader, therefore, in the position of a Chaldæan observer, Mr. Proctor shows, in a style peculiarly clear, how, on the true system of the universe being known, from simple and easily ascertained data conclusions of the most important character are deducible. To begin with the discovery of the planet in question, a discovery the explanation of which, as well as of its apparent motion, and of very much more in the book, is "applicable, with suitable changes in matters of detail," to other members of the solar system, thus rendering the work, though professedly limited to the consideration of one planet only, a valuable treatise on general astronomy. An Eastern shepherd, gazing night after night through the clear depths of his matchless skies, has his attention for the first time attracted by a dull yellow star. He is probably possessed of a rough map of the stars, and on referring to it cannot satisfactorily determine that the one in question is indicated.

He therefore marks down its place, and again and again directs his gaze towards it, until before long he fancies that it does not occupy quite the same relative position as it did when he first noticed it. With a curiosity thus excited he patiently continues his examination, until at length, to his inexpressible joy, the wandering nature of the strange star becomes a matter of certainty. He then traces its apparent course along the zodiac and begins to reason on the data ascertained, and by a variety of simple processes, which even the unscientific reader cannot fail to follow and comprehend (especially as they are illustrated by admirably-executed diagrams and star maps), determines approximately its distance, velocity, and period. Our limits forbid anything like a detailed examination of these processes. We may say, however, that the entire mathematical treatment of the subject is unusually clear and forcible. So soon, however, as the author gets beyond the region of demonstration, he appears to us to lay aside his usual clear-sightedness, and often to see things as through a haze, his reasoning from evidence which is only probable appearing much less forcible than it is when that evidence is demonstrative.

Before, however, noticing any of those matters on which we are compelled to differ from the author, we must call attention to one feature of the work which in our opinion greatly enhances its value. In the second appendix are a number of important tables, in each of which two values are given for every element whose determination depends on the sun's distance. The first values, which are the ones usually given in astronomical works, are those deduced from the solar parallax $8''{\cdot}5776$ given by Encke. But more modern researches have tended to show that this is too small, and that consequently the sun's distance, which depends on it, as well as the distances of all bodies which are estimated in terms of the sun's distance, are too great. Since this was first pointed out by M. Hansen it has been confirmed by two entirely independent methods, *viz.* by M. Foucault's determination that the velocity of light has hitherto been overestimated, the true velocity making the sun's distance correspond with the suggested alteration, and by the determination as the result of a system of observation set on foot by Dr. Winnecke, Vice-Director of the Observatory at Pulkowa, that $15''$, the received value of the horizontal parallax of Mars when in opposition, is too small by about $\frac{1}{27}$ part, thus giving a corrected value, from which likewise the old estimate of the sun's distance from the earth is shown to be too great by about the same quantity as by the other plans. With this newly suggested and highly probable estimate the second values in Mr. Proctor's tables correspond.

Though not mentioned in the title-page, some space is devoted to a rapid sketch of the progress of astronomy from very early to very recent times. Such a sketch, however interesting in itself, would, perhaps, have been hardly relevant, had not each great discovery as it is described been applied by the author to the illustration of some point with reference to Saturn. It is a curious circumstance, and one not noticed by Mr. Proctor, although in the shape of footnotes much curious general information is thrown in, that Copernicus, the originator of one of the greatest revolutions in modern science, a revolution

too, directly opposed to the faith of the Catholic Church, should have been a most determined enemy of his fellow-countryman and contemporary reformer in another field, Luther, against whom he signed an edict issued in 1526. In the application of Kepler's third law to the case of Saturn, the language is very obscure. This is the more noticeable as obscurity is a rare fault throughout the work. Even when the reasoning seems inconclusive the statements are clear. At page 39, however, when inquiring into the relation between the numbers 9·53885, or Saturn's mean distance in terms of the mean distance of the earth, and 29·4566 or his period in terms of the earth's period, it is said "the first is less than the second, but the square of the first is plainly greater than the square of the second" (than the second ?) "We must therefore try higher powers of the second" (of the first ?) "Trying the next power, that is, the square of the second, we immediately find the relation we are seeking:—thus, the square of the first number is less than the square of the second, but the next power or cube is almost exactly equal to the square of the second."

In July, 1610, Galileo began to examine Saturn with his largest telescope, discovering as he thought that the planet was triform. Examinations thus initiated led eventually to the discovery of the three rings and eight satellites. As Mr. Proctor adopts as the basis for a new theory on the nature of the rings, the grounds advanced by M. Otto Struve, in 1851, in his work "Sur les Dimensions des Anneaux de Saturne," in support of the hypothesis that the rings are rapidly advancing towards, and will ere long be precipitated on to, the globe, we shall devote a short space to an examination of the validity of these premises. They are as follow:—Since the time of Huygens, the width of the ring system, as determined by proportional admeasurements, has been steadily increasing by the approach of its inner edge to the globe; the dark ring since November, 1850, the date of its discovery, has itself been observed to increase considerably in width. The breadth of the ring was found by Huygens to equal that of the space between it and the globe. Herschel, 107 years later, found the ratio between the width of the ring and the space to be as 5 : 4, while still later observers have found it to be yet greater. Do these admeasurements form a sufficiently sound basis on which to rear a novel hypothesis? We think not. Before stating our reasons for so thinking, we would remark a statement of the author's which seems in itself sufficient to throw doubt on its soundness. He says that Pound made the width of the system less than that of the dark space, but that he selects Huygens's measurements as less favourable to his case. But would Pound's measurements have favoured the case? If they had been made before Huygens's they might have been thought to do so, but the truth is that they were made after his, and therefore on the supposition that both are equally reliable, they should be taken to indicate a *diminution* in the breadth of the system between the two periods of measurement—an occurrence which would militate against that uniform increase in breadth on which the whole question rests.*

* Huygens's measures were taken in 1657, Pound's in 1719.

But there is abundant reason independently of this for hesitation before admitting Mr. Proctor's premises. Thus micrometric measurements are liable to so many sources of uncertainty, that scarcely any two observers agree in giving the same result for the same object. Comparatively little weight can be attached to the breadth of the black division, in consequence of the great difficulty and uncertainty of the contacts of the points of reference with its borders. Other circumstances besides these show strongly how such values may be affected. The value of the semi-diameter of the ball, for instance, made when the rings are visible, is sensibly smaller than those made during its disappearance, a circumstance arising probably from the glare of the rings preventing the true border of the planet from being seen. Moreover, the following curious observation was made by Mr. Main, who fully investigated this subject some few years since, *viz.* that in two series of measurements which he made of the globe and rings in two distinct years, several of the first measures of each year made the breadth of the rings conspicuously less than that of the dark interval, that the difference between the two steadily decreased till they were equal, and that then the breadth of the ring became greater and that the ratio between them steadily increased. Now as it will not be denied that observations made continuously by the same person, with the same instrument, in the same way (supposing observer, instrument, and method to be of the best kind, which will be readily granted in the present case), are far more reliable than those which, being made by different persons, instruments, and methods, are subsequently reduced to a uniform standard by a presumed allowance for all variations, the legitimate conclusion from the above would seem to be that Saturn's ring system underwent, during each of the two years in which these examinations were made (and, if these are to be taken as particular instances of a general case, is continually undergoing), periodical changes of very great magnitude. Yet there are very few who, considering the uncertainties to which such measures are liable, would not hesitate to draw an inference of this kind, and who would not rather suspect the changes to be due to optical causes. But, as we have said, these results greatly affect the importance of a theory on the nature of the rings advanced by Mr. Proctor, and it is therefore probable that he has allowed his mind to be unduly biassed in the direction that would give it support. What are the rings? The chapter devoted to the discussion of this question is a highly interesting one, and the conclusion arrived at, after a review of the various conjectures that have been entertained on the subject, is that "they are composed of flights of disconnected satellites so small and so closely packed, that at the immense distance to which Saturn is removed, they seem to form a continuous mass." This hypothesis, which was first advanced by Cassini, may possibly be as true as it is ingenious, and the most recently expressed views in cosmical philosophy, if they do not support, certainly cannot be said to contradict it. This, however, is not saying much. A hypothesis so strange requires very strong evidence to render it acceptable, and we shall here inquire how far Mr. Proctor has *proved* his case, and whether the

actual phenomena observed on the rings are so utterly irreconcilable with the idea of their continuous fluid or cloud-like structure as to render necessary its adoption in place of the one more generally received. The grounds on which he bases his opinion are partly *à priori*, partly certain phenomena which the hypothesis is supposed best to interpret, and partly exact mathematical inquiry. They may be thus stated :—First, rings of disconnected satellites are not uncommon in the solar system ; the ring of asteroids between the orbits of the Earth and Mars ; the belt of small bodies through which the Earth is supposed to pass twice in the year ; the Zodiacal light, &c., being examples. We are not therefore to be unprepared for meeting with them in other situations, as for instance, around Saturn. Secondly, the following phenomena have been observed and require to be accounted for : all the rings often exhibit traces of divisions which form portions of different concentric circles, those on the bright ones being mottled, dusky, and very evanescent. The dark ring is transparent and allows the planet's disc to be seen through it undistorted. In 1856 a darkening of the inner bright ring was observed at the points where it lay nearest to the extremities of the apparent longer axis of the dark one. On the disappearance of the rings, a faint hazy bordering on either side of each ansa, and extending outwards to a variable distance from the ball nearest to which it was thickest, has more than once been seen. Lastly, as the result of independent mathematical inquiry, it was proved by La Place that for a solid flat ring to remain in equilibrium about a globe like Saturn's when subjected to the disturbances which Saturn's rings actually experience, it must rotate so as to give to each particle the same velocity that it would have if it were a free satellite, and, unless it were imagined to be in unstable equilibrium, that it must be biassed. The degree of bias, or the distance at which the centre of gravity would require to be from the centre of figure, he did not determine. Mr. Clerk Maxwell, taking up the question at this point, has proved that it would require to be nine times as far from its lightest as from its heaviest side, an arrangement which cannot exist, because if it did it would make the appearance of the system very different from what it actually is. Yet if the nebular hypothesis be true the rings must be solid, for on it their formation must have taken place in a period between that of the satellites and that of the globe, and as these extremes are solid, the intermediate bodies would probably be so likewise.

These, briefly, are the grounds on which Mr. Proctor constructs his hypothesis. Space forbids our doing much more, so far as the *à priori* part of the evidence is concerned, than to point out how little real analogy can be established among the cases of ring systems brought forward. Take that of the asteroids. The entire mass of these must fall very far short, on the most liberal calculation, of one-millionth part of the bulk of the Sun ; while Saturn's rings, from their observed effect in disturbing Titan, are considered to be not less than $\frac{1}{118}$ of his mass. The Zodiacal light again has by no means been so certainly proved to result from flights of small cosmical bodies as to make it prudent to adduce this interpretation as a positive fact in Science, from

which to illustrate other presumed analogous facts. The same may be said with regard to the employment of the Nebular hypothesis, as though, instead of being what it is, a highly probable supposition, it were an established certainty. But the second kind of evidence, that derived from observation, is the one on which the opinions of Mr. Proctor ought to find their securest support, and yet here their most serious difficulties are experienced. The author seems to feel this, and labours earnestly to disprove the existence of a cloud-bearing atmosphere, the presence of which, if it could be established, would satisfactorily account for many of the phenomena, and be contradictory to none, and would therefore render his hypothesis unnecessary. Yet it seems to us that, besides the phenomena mentioned, all of which either support or are not directly antagonistic to the hypothesis, there are others which, while they are readily explicable on the supposition of an atmosphere enveloping the rings, will, on any other supposition, remain strange. Such, for example, is the absence of any perceptible shadow on the planet's disc when the plane of the ring passes through the Sun. Now if the ring had even the least thickness ever ascribed to it, *viz.* 40 miles by Bond, it would be sufficient to produce a total eclipse of the Sun on Saturn's equator, if no qualifying agency operated, as it would subtend an angle more than double that subtended by the disc of the Sun as seen from the planet. As no such eclipse is produced, we must look for some cause competent to prevent it. Such a cause is readily found in a somewhat dense atmosphere, which, if it existed, would probably produce just the modification described, for the light, by refraction through it on both surfaces of the rings, would reduce the shadow to a slight and undistinguishable penumbra.* On the same supposition also another phenomenon, *viz.* the visibility of the ring system, when its unenlightened side is turned towards the Earth, is readily accounted for, while on Mr. Proctor's hypothesis these seem to us to meet with no explanation. Moreover, in support of his opinions, the author considers the greater visibility of the dark ring in modern times to be due not to improvements in the telescope, but to the fact that its formation is only of recent date. Yet it seems to us by no means certain that this ring was not observed nearly a century and a half ago. In the number of the Royal Society's Abstracts for April 6, 1720, the following notice appears of a paper read by Hadley:—"Within the ring he discerned two belts, one of which crossed Saturn close to its inner edge and seemed like the shade of the ring upon the body of Saturn, but when he considered the situation of the Sun with respect to the ring and Saturn, he found that the belt could not arise from such a cause." And again, in a later notice,—"The dusky line which in 1720 he observed to accompany the inner edge of the ring across the disc continues close to the same, though the breadth of the ellipse is considerably increased since that time." This was written in 1722.

In the chapter devoted to the discussion of Saturn's habitability the reasoning appears somewhat deficient in force. After expressing

**Vide* a paper by Rev. R. Dawes, in 'Monthly Notices, Astr. Soc.,' vol. for 1861.

a belief from general analogy that the planet is inhabited, and after labouring apparently to prove a similarity between its conditions and those on the Earth, the author concludes that it is probably "not a suitable habitation for beings constituted like the inhabitants of our globe." But if it can be clearly shown that the physical conditions are irreconcilable with the existence of living beings like those which now tenant, or are known to have tenanted, the Earth, all other inquiries must be beside the question; and we cannot understand how, on the principles employed, inhabitants can be granted to Saturn, and yet denied to the Moon, or even to the Sun. In his notes on the habitability of the Moon, Mr. Proctor confines himself to the discussion of certain interesting but doubtful questions, and does not offer any opinion as to our Satellite's being the abode of living beings; yet, from the general tenour of his language, we infer that he considers it uninhabited. But why, if Saturn can be supposed to be the abode of beings different from any on the Earth, may not the Moon be supposed the abode of others different from those on either? The only life we know anything about is life in its terrestrial manifestations. This life requires certain conditions, and if they are absent it must be absent also. Further than that we are not warranted in going. We cannot say that, although the only kind of life we do know anything about is impossible because of the non-existence of some of its essential conditions, yet some other form of life probably is present. But are the conditions on Saturn such as necessarily to shut out life in this restricted sense? We cannot agree with the author that the dimness of the planet's light and the length of its year are so, when there is abundant proof of life on the Earth in situations from which light is absent altogether, and where the conditions, instead of only varying in long intervals, never vary at all. Many things have yet to be determined with respect to the light which reaches the outer planets, before it will be prudent to speak positively as to its dimness. The great reflective capacity of the globe and rings in the case of Saturn, and the photographic intensity of this reflected light, have already been clearly established. The matter is still under inquiry, and in the number of the 'Comptes Rendus' for June 5th is a very interesting communication from Father Secchi, in which the identity in many respects of the atmospheric conditions of Jupiter and Saturn is pointed out. As Mr. Proctor himself states, the light to the Earth was possibly much less in earlier times, when huge creatures of the bat kind were relatively very abundant. All his reasoning from palæontological data, however, is not so reliable even as this. It seems strange, for instance, to hear the cumbrous forms of extinct animals adduced as a reason for supposing that the dimensions of our planet were once much larger than at present, and therefore gravity at its surface less, when some of the hugest and most weighty of them lived only so recently as the later Tertiary period, during which there is no reason for thinking the size differed from what it is now.

The discovery of the disturbance of the periods of Jupiter and Saturn, known as the long inequality, when first made by Halley, was thought to throw doubt on the law of gravitation. The effect of mutual

attractions in causing deviations from the simple elliptical orbits of the planets had long been recognized, but it was imagined that such disturbances must necessarily be of short duration only. Ultimately it was proved by La Place that the discrepancy, instead of militating against Newton's theory, served to establish it upon a firmer basis. The inequality was shown to result from the mean motions of the two planets being nearly commensurable, five times Saturn's being nearly equal to twice Jupiter's. The whole question is discussed with admirable clearness in one of the most interesting chapters in Mr. Proctor's book.

In the note on Chaldæan astronomy much curious information is given. The Chaldæans were probably among the earliest, if not the earliest, of astronomers. An old tradition, preserved by Berosus, states that Abraham taught the Egyptians astronomy and mathematics. But that they were acquainted with the true system of the universe does not seem so probable. In his effort to prove that they were, the author strives to dissociate them from the Greeks, who, it is certain, were not. He considers it clear that little connection exists between the mythology of the two people; yet the likeness is strong enough to show that one was probably influenced by, if not derived from, the other. The practice of colouring their statues and temples, for example, was common to the two. And if the Greeks did not derive their astronomical system from the Assyrians or Chaldæans, whence did they get it? While if they did, it seems improbable that they should have had a false system, while the people who taught them held the true one. That the Greeks derived their system from a people who dwelt far south of Athens seems as clear as that the Indian system was obtained from a country north of Benares, for Aratus, in his description of the constellation of the Altar, says that it is seen above the horizon for the same length of time as Arcturus is below it. But the constellation is not wholly visible from a latitude higher than 30°, a latitude far south of Athens, and agreeing with that of Persepolis and the country near the head of the Persian Gulf. With regard to the connection between the mythologies of Greece and Assyria, a connection which the author denies, we are tempted to quote the following very extraordinary prophecy by Niebuhr, which was uttered many years ago and reported to Mr. Layard by one who, as a pupil, heard it:—"There is a want in Grecian art which neither I nor any man now alive can supply. There is not enough in Egypt to account for the peculiar art and peculiar mythology which we find in Greece. That they did not originate it I am convinced, though neither I nor any man now alive can say who were the originators. But the time will come when on the borders of the Tigris and Euphrates those who come after me will live to see the origin of Grecian art and Grecian Mythology."

We cannot leave without expressing the strongest commendation of the beautiful engravings with which Mr. Proctor's book is illustrated. They are models of illustrative art. At the end is a concise but clear explanation of the astronomical terms used throughout the work, which will be found very useful to the general reader.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT BIRMINGHAM, September, 1865.

The President's Address.

There are periods in the career of every fortunate adventurer, especially in that of a trader, when a lull supervenes upon long-continued activity and a series of successes.

The natural occupations of such a brief period of repose, are a careful investigation of accounts; a stock-taking; the preparation of an accurate balance-sheet; and, as the sequence of these, a very comfortable kind of feeling that, whatever may lie hidden in the future, the past and present have at least nothing in them to be regretted, and are fit subjects for rejoicing and congratulation. Of course on such occasions the "managing man" plays the most conspicuous part, and comes in for a large share of the credit, if not on the balance-sheet, at least of the honour of having aided in producing such a gratifying document. Then it is that he is taken into the special confidence of "the house," perhaps into partnership, and then he finds the long labour of years crowned with an honourable reward.

Professor Phillips was for a long period of years the "managing man" of the "British Association for the Advancement of Science." He was at its foundation, and until very recently was its general secretary. His name is associated with all its successes; and in its poorer days, when the great mass of laymen thought little of the movement, he was as hopeful as he is to-day, and followed it through its stage of probation. Now a period of repose has come in the scientific world, and Professor Phillips, who is made the head of the concern for the year, has struck a balance sheet; talks to the partners concerning their past successes, fights their battles o'er again, reminds them what they said and did when they were young beginners, and what they think, and say, and do in the hey-day of their prosperity.

"Such, gentlemen," he says, "are some of the thoughts which fill the minds of those who, like Brewster, and Harcourt, and Forbes, and Murchison, and Daubeny, stood anxious but hopeful at the cradle of this British Association, and who now meet to judge of its strength and measure its progress. When, more than thirty years ago, this Parliament of Science came into being, its first child-language was employed to ask questions of nature; now, in riper years, it founds on the answers received further and more definite inquiries directed to the same prolific source of useful knowledge."

Is it not as we have said of the commercial adventurer?

"First, we embarked poor upon the great sea of thought, inquiry, and investigation, and were content to earn shillings: with the shillings we set out again, and returned with sovereigns; and now we

are prepared to invest in large ventures, and to reap harvests of bank-notes." And he glances too at the ledgers of past years (referring his hearers to the 'Annual Volumes of Transactions' of thirty years), and tells them they will there read of profits heaped upon profits, concluding with a sigh that there is only one thing to be regretted; he is afraid that some of their ventures have been more profitable to third parties than they have been to themselves. But then he consoles himself with the philanthropic reflection, that it is all good for trade, and with that kindness of heart which characterizes old-established concerns having a larger business than they are able to manage themselves, he congratulates the partners in having been the means of starting a number of new establishments; and as these have after all been feeders, and have added *éclat* to the parent Congress, "the regret was soon lost in the gratification of knowing that other and equally beneficial channels of publication have been found" for transactions which the books of the great house were too small to contain.

These few remarks will convey to the reader some idea of what he may expect to find in the Address of the President, who has but little to say of the progress of Science since the last meeting, for there has been a remarkable lull in the business of scientific discovery and research. He touches cursorily upon the subject of Radiation, showing how recent experiments upon the passage of light have modified our ideas concerning the distances of the heavenly bodies from this world; and glances *en passant* at the physical and probable vital conditions of other spheres, and at the influence of changes in the sun's photosphere in creating magnetic disturbances upon the earth's surface. Spectral analysis, as applied to the determination of cosmical elements in the heavens, whether in suns, planets, satellites, or nebulæ, receives a passing notice; so, too, the application of Photography to Astronomical Science; and then the recent achievements of meteorologists are dwelt upon, and a touching reference is made to the "gentle spirit which employed this knowledge in the cause of humanity," and "which passed away, leaving an example of unselfish devotion,"—the late Admiral Fitzroy.

Crystallography and Chemistry (more especially synthetic) are brought under notice, and then we have a bright little panorama of the progress of Geological Science, and "step by step we are guided through the old Cambrian and Silurian systems, rich in Trilobites and Brachiopoda, the delights of Salter and Davidson; with Agassiz and Miller and Egerton we read the history of the strange old fishes of the Devonian rocks; Brongniart, and Göppert, and Dawson, and Binney, and Hooker unveil the mystery of the mighty forests now converted to coal; Mantell and Owen and Huxley restore for us the giant reptiles of the Lias, the Oolite, and the Wealden; Edwards and Wright almost revive the beauteous corals and Echinodermata; which with all the preceding tribes have come and gone before the dawn of the later periods, when fragments of mammoths and hippopotami were buried in caves and river sediments to reward the researches of Cuvier and Buckland, Prestwich and Christy, Lartêt and Falconer."

Of Man, his antiquity and origin (the latter being linked by him with his brief passing observations on the "Origin of Species"), Professor Phillips speaks very cautiously, and in one instance, as it seems to us, too much so. He appears, notwithstanding his sincere protest to the contrary, to approach that bugbear of modern Science, "descent by modification," with timid steps, and with some apprehension lest he should offend the orthodox; and there will doubtless have been many a smile amongst our fast men of Science and thorough-going Darwinians, when they read his remark that "often out of the nettlesof danger, we have plucked the flowers of safety."

Unless we misapprehend the author's meaning (and it is not our fault if we do, for he is too cautious to be explicit), his observation brings before us again most vividly the staid "managing man," who, when he sees the younger members of the firm embark in hazardous ventures—employ steam and the telegraph instead of the safe old barque and, at most, the estafette, as he did—cannot help feeling that even if all be right, and the "flowers of safety" may be plucked "from the nettles of danger," the speed is far too great for his taste. Of course we revere and admire the white head none the less for its doubtful shake, and wish indeed that a little of its cautious contents might be transferred into the crania of some of those who, it would almost appear, are engaged to do the comic business of the Association; for whom modern views of Science are far too slow, and who conceive that they can best elevate themselves in the scale of humanity by bespattering and humbling their fellow-creatures.

But, whilst we can to some extent sympathize with Professor Phillips in the caution with which he approaches this "development" question, there is one matter in which we consider him to have committed a grave oversight.

The fathers of Science he pets and holds up time after time to admiration, and as our eye glances over his Address, we see the names of Priestley and Watt; Tyndall, Joule, Grove, and Rankin; Sabine, Kirchhoff, Rose, and Herschel; Humboldt and Glaisher (and Coxwell!); Airy, Hamilton, Whewell, Miller, Liebig, Hofmann, and many more of that rank; men who have earned their honours and their titles, and many of whom belong to the Upper House of "this Parliament of Science;" but we look in vain for the helping hand held out to the younger men, to those who will constitute the future of the Association of which Professor Phillips was one of the founders; to that class to which he essentially belongs.

It is true that "Naturalists' Field Clubs" are named, and we are told that "wherever and by whatever means sound learning and useful knowledge are advanced, these to us are friends;" but is the President aware that, two days after he delivered his Address, there met in a room of the Midland Institute, a few delegates representing the great body of Science-teachers of the country, to "consider the best methods of forwarding the Science Scheme of the Department," and of forming an Association "for advancing the interests of Science-teaching as a profession?"

It would be ungenerous if we were not to state frankly that we

believe this omission in the President's Address to have been unintentional, for we know he is the first to recognize true merit and give his aid to rising talent and faithful labour in whatever sphere of society it is to be found. His year of office has fortunately but just commenced; and we trust that he will remember that if there has been but little of novelty of late in pure and experimental science, a great effort is just now being made to impart practical instruction to the masses by a number of disinterested (chiefly young) men, who will assuredly at no distant period be the mainstays of scientific truth.

The President's Address is couched in most beautiful language, and presents an example of what may be produced by one who has enjoyed an academical as well as a scientific training, and we cannot do him greater justice than by borrowing his opening remarks as a conclusion to this brief commentary; feeling assured that they have been, or will be heartily assented to by the devotees of Science in every land.

"Assembled," he says, "for the third time in this busy centre of industrious England, amid the roar of engines and the clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly falls upon the ear the accent of Science, the friend of that art, and the guide of that industry! Here, where Priestley analyzed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge. And when, on other occasions, we meet in quiet colleges and Academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilized, and the condition of human society exalted!"

Physical Science. (Section A.)

The proceedings of this Section were opened on Thursday, Sept. 8th, by an able address from the President, W. Spottiswoode, F.R.S., in which the various discoveries and advances made in Physical and Mathematical Science during the year were passed in review. The President commenced by remarking that the great range of subjects comprised in this Section, and the multiplicity of papers submitted to it, have doubtless contributed to deter his predecessors in this chair from preparing addresses so elaborate and comprehensive as those delivered to other Sections. The custom, however, of prefacing the business proper by a short summary of subjects which have engaged the attention of philosophers during the past year, and which may therefore be expected to come before them during the present sittings, appears to be sanctioned by the wishes of the members, and might perhaps be followed without materially departing from that brevity which is here both customary and desirable.

In giving a notice of the papers read before this Section, space compels us to confine our remarks to those subjects only which have not before been treated of in these pages, and which appear of general interest.

The first day's proceedings commenced with the report of the Electrical Standards Committee, which was read by Mr. Fleeming Jenkin. In it were described the steps which had been taken with a view of obtaining an unvarying standard, and the subsequent distribution of coils, each expressing the British Association standard of electrical resistance. If these coils retained their value some confidence might be felt in the permanence of the unit they had arrived at. There were differences in the unit obtained by silver wire, &c., and the unit obtained by means of mercury, but it might be expected these differences would eventually disappear. The coils had been distributed widely, so that they would be available to actual electricians, and the telegraph companies had opportunities of using them. The unit had been introduced into India and our Colonial possessions, but it would take long before it was adopted on the Continent.

Mr. James Glaisher next read the report on "Luminous Meteors." He said the subject included the familiar appearance of shooting stars and fire-balls; and it was one which, long neglected, yet merited the consideration of those best able to speculate upon it. But few such appearances have been observed during the past year, partly owing to the presence of clouds, and partly to the absence of certain of the meteors usually seen in January, April, and August. A set of maps had been completed for the use of the committee, and they were presented with that report. Various instances were given of the appearance of meteors, and reference was made to the sound caused by them, a phenomenon which, it was hoped, would be explained by continued observation. Mr. Newton conjectured that these meteors were not fragments of old worlds, but that they were composed of matter out of which new worlds were forming. The committee hoped the grants would be continued, so as to enable them to add to the catalogue of nearly 2,000 meteors contained in the maps of the Association. Accounts were then rendered of different "fire-balls" which had been observed, and Mr. Glaisher concluded by referring to some of the details given in the appendices.

After a paper by Mr. Sabine, "On a new Method introduced by M. Siemens, of measuring Electrical Resistance," Mr. Hooper introduced the subject of "India-rubber as an Insulator for Telegraphic Conductors." He detailed the difficulties which had opposed the successful adoption of india-rubber insulation, and showed how he thought it might be advantageously adopted. In a certain stage of india-rubber manufacture, and under certain conditions, it became susceptible to decay; but there were means of securing a perfect insulation by india-rubber, and it had peculiar qualities which made it specially suitable for telegraphic cables. Twenty per cent. more messages could be sent by a cable insulated with india-rubber, than could be sent by one

insulated with gutta-percha. The subject, therefore, had an important bearing in a financial point of view, as well as in other respects.

This paper was followed by a discussion upon the causes of failure of the Atlantic Telegraph, on which remarks were made by Messrs. Siemens, Fairbairn, Fleeming Jenkin, Cyrus Field, Capt. Selwyn, and O. Byrne.

Mr. H. C. Sorby then briefly described his new form of Spectrum Microscope. He mentioned its powers and uses in several instances, and amongst others, said that in identifying blood marks, they could employ it to detect the most minute stains: even of the one-millionth part of a grain they could have a perfect spectrum.

The proceedings concluded by a brief description by M. Claudet of his "Moving Photographic Pictures," detailing the means by which this effect was produced.

The proceedings of Friday, the 8th September, opened with the report of the "Lunar Committee," read by Mr. Glaisher, the chairman, which treated of the steps taken by the Committee during the past year to prepare a large and accurate map of the moon's surface.

At the conclusion of this report Mr. Birt (Secretary to Lunar Committee) read a paper "On the Progress of the Map of the Moon." Mr. Birt described by a diagram, how the moon's surface was divided and subdivided into sections, the larger parts being designated by a letter of the Roman alphabet, and the smaller divisions by the smaller letters of the Greek alphabet. By this means they could record any observations they had made, in such a way that observers coming after would be able to discover the locality. Having described the telescopes used in making observations, Mr. Birt went on to speak of various conspicuous objects on the moon's surface, such as the crater "Plato," the "Teneriffe mountains," the "Dionysius Crater," the "Railroad," the "Terra Photographica" of Mr. Warren De la Rue, &c., pointing them out in a diagram as he proceeded with his remarks.

The next communication was by Mr. Balfour Stewart and Mr. J. P. Capello, "On the Magnetic Storm of the Beginning of August last, as recorded by the Instruments at Kew and Lisbon."

Having described the means of ascertaining the value of the force which disturbed the needle, Mr. Stewart said the storm he was about to describe was the very great magnetic storm which many would remember from its having occurred at the time anxiety began to be felt about the Atlantic cable. It had many curious points, and was very similar to a great magnetic storm which occurred in August, 1859, being accompanied by great auroral phenomena and disturbance of the telegraph wires. There were instruments in the Observatories at Kew and at Lisbon, by the aid of which any disturbance was continually recorded by the aid of photography. The characteristics of a magnetic storm were not local in their nature, but cosmical, affecting different places at the same time. The way in which the storm of August affected the magnet was almost the same at Lisbon and Kew. It broke out on August the 1st, and lulled and

then broke out again in the early morning of August 3rd. This lasted till midnight, and the disturbance then ceased altogether for twenty-four hours, renewing itself on the following day. Mr. Stewart exhibited drawings, showing the nature of the magnetic disturbance, and then compared it with the greater outbreak of August, 1859. Both consisted of two separate outbreaks, and both began during the hours of night or early morning. One peculiarity accompanying both storms was that there was at the time many spots in the surface of the sun. Many of them rapidly altered their size and their character, and one of these phenomena consisted of a bright spot of light rapidly crossing a dark spot on the surface of the sun. In conclusion, he said that it would be hasty, at this stage of our knowledge, to jump to any conclusion on the subject.

The physical papers this day concluded with an interesting notice by Dr. J. H. Gladstone, "On the Refraction Equivalent of Carbon;" the remainder of the papers being strictly mathematical.

On Saturday the 9th September, the proceedings opened by Professor J. D. Forbes reading a paper on "The Laws of the Conduction of Heat in Iron Bars," being a *résumé* of observations made with the aid of a grant from the Association. The subject had occupied his attention for the last fourteen or fifteen years, and was a very old problem. He had reported in 1852 on the progress he had then made in his experiments, and he now came forward to explain what he had done since in that respect. He had, without reference to either the precise mathematical or physical laws on which such estimates had been based by different philosophers, sought to determine the loss of heat from a given bar by direct experiments, and without necessarily inquiring what the precise law is. At the same time his experiments could not be quite regarded as conclusive, and he would be very glad if some member of the Association would extend them.

Mr. J. P. Gassiot, V.P.R.S., next read a paper, "On the Change of Form and Colour which the Stratified Discharge assumes when a varied Resistance is introduced in the Circuit of an extended Series of the Voltaic Battery." Mr. Gassiot operated with a battery composed of 4,000 insulated glass cells, and instead of sulphate of copper, as used by the late Professor Daniell, he put about a table-spoonful of sulphate of mercury into each cell. The elements, carbon and amalgamated zinc, were then introduced into the cells, which were subsequently filled with rain-water. When one of the wires of the battery is inserted in the water, and the other wire touches the moistened surface of the glass, but is not in actual contact with the water, a luminous discharge is produced, entirely filling a tube which is prepared to receive it, without any appearance of stratifications. On depressing the wire, discs of red light are rapidly produced from the positive pole, and on further depression nineteen only of these discs remain in the tube, and these are much increased in brilliancy and distinctness. On still further depression, other singular and highly beautiful effects are produced. Mr. Gassiot

said that these phenomena, which he characterized as entirely novel, could be obtained with any insulated battery.

A paper "On Spectacles for Divers, and on the Vision of Amphibious Animals," was then read by Captain Galton. The author said those who had surmounted the usual repugnance of beginners to keep their eyes open under water, found, if they did so, that nothing was to be seen with distinctness—everything they could see at all, was seen through a haze; so that if the hands were held out to a distance of eight inches before the face, it would be impossible to discover the space between the fingers, even if they were spread out as widely as possible. If he looked through a tube into a vessel of water perfectly still, he saw all objects at its bottom with perfect distinctness, only a little out of their position through the effects of refraction. But upon lowering his head he found that the instant his eye touched the water all distinctness vanished—the convex surface of the eye-ball had indented the plane surface of the water, and turned the tube into a convex lens. If they desired to counteract this they must use a convex lens of such power that its effect should be exactly opposite to that of the concave water lens. A lens to answer that purpose he had made and now produced. Furnished with spectacles on such a principle, they might expect to see as well under water as on dry land. Men going down in diving bells did not require such aid; through the plate-glass inserted in the diving dress, they could see clearly when in the water. He designed his contrivance to be useful to the pearl-diver, to the sailor requiring to examine a ship's bottom, to men seeking in the water anything they may have lost there, and to bathers generally, to whom he promised that the possession of these spectacles would add much to their enjoyment. They would find they had acquired a new power. With respect to the amphibiæ, he thought their power of accommodating the vision was wholly inexplicable by any theory he had heard promulgated. The hippopotamus, otters, water-rats, and diving birds of various descriptions, apparently saw as well in water as on land. The cornea of the seal appeared to be very flat, but it was far otherwise with the rest of the amphibiæ.

Captain Selwyn then read a paper, "On some New Arrangement of the Poles in Magnets," in which he described an experiment he had made on this subject. A steel bar having been prepared and hardened as usual, was magnetized by any ordinary means—either by touch or an electric current. Then, either at the centre or any other point of the bar, where it was desired, the temper was taken out of the bar by a rod of heated metal or by a blow-pipe, when it was found that this operation separating the bar into two magnets, the ends of the bar still remained respectively north and south.

The last paper in the Section this day was one by Mr. Harrison, "On the Heat attained by the Moon under Solar Radiation." After referring to various theories on the subject, Mr. Harrison expressed his opinion that a small modicum of heat having been detected in the course of researches into the question made by Professor Smythe at Teneriffe, justified the assumption that the moon's radiant heat was

expended in dispelling cirri cloud and vapour before it reached the earth's surface. The heat of the moon at the last quarter, or a day or two after entering that phase, seemed to be greater certainly than when at the full.

On Monday, the 11th September, the proceedings in Section A commenced with the Report of the Balloon Committee, read by Mr. Glaisher. It stated that the committee had been re-appointed last year, in order, 1st, to examine the electrical condition of the air at different heights; 2nd, to verify the law of the decrease of temperature, as found from summer-day observations already made, with day observations at other seasons of the year, but principally in the winter and adjacent months; 3rd, magnetical experiments; observations with the spectroscope, the currents of the atmosphere, solar radiation at different heights, and hygrometrical observations, though secondary, were to be held as very important subjects of investigation; 4th, to arrange for observations at night, and to make such observations if possible. With respect to the first subject, no farther progress had been made, the instrument prepared for the purpose not having been rendered available for use. Under the second and third heads some progress had been made, though not to the extent anticipated. As to the fourth object, no night observations had actually been made. To take such observations it was imperatively necessary to have some means of illumination, so that the instruments could be read. Various suggestions had been made on this point, but the best plan seemed to be to employ a Davy lamp. Two such lamps had been made of copper, for Mr. Glaisher, so that the proximity of magnets did not affect them. Experiments had shown that these lamps might be used with perfect safety, and that they kept well alight, besides affording a source of grateful warmth not before possessed. All necessary arrangements were now made for night observations, and a series of such observations would be very useful, though there were no results yet for presentation. The same instruments, with the addition of a fine spectroscope and a delicately-mounted magnet, had been employed, as during the previous year. The instruments were attached to the outside of the car, and were easily read in that position. Up to the last meeting of the Association twenty-two ascents had been made, of which seventeen had taken place in June, July, August, and September, and five only in the other months of the year, *viz.* one in January, one in March, two in April, and one in October. Of the summer ascents, one had been made in the morning, and the rest in the afternoon or evening. The committee considering that day and night experiments in summer had better be brought together before more were made, Mr. Glaisher devoted all his efforts to secure as many ascents as possible between October and April, but he had succeeded in three instances only, on December 1st and 30th, 1864, and on February 27th last. The three ascents were made from Woolwich, and the paths of the balloon were shown in diagrams. The small number of ascents was due to winter being an unfavourable season for balloon experiments. But as with regard to the progressive diminution of temperature with elevation,

the diffusion of vapour in the atmosphere, the density of clouds, their extent and currents in the atmosphere, and all connected with the higher regions of the atmosphere in winter, we are in almost entire ignorance; on this account winter is the most important season for experiments. The winds prevailing in the higher regions in January and February were W. and S.W. This was unfortunate in regard to the ascents, as it necessarily shortened their duration.

Mr. Glaisher's disappointment at finding his time for observation always cut short by the inevitable tendency of the balloon towards the sea, was compensated for when he considered the high importance of the continuance of the south-west winds in winter. Constant observation last winter, from October to March, had found the wind always in the same direction, whenever it was possible to determine the motion of the upper air, no matter from what quarter the earth-wind came. The high temperature we experienced in winter seemed due greatly to this current, which met with no obstruction in its course towards us, but blew directly hither and to Norway over the Atlantic. These winds only reached France when they had passed over the whole of Spain and the Pyrenees, and they had then become so much cooled that France derived comparatively little benefit from them. This apparently caused the more severe winters in that country. It was probable that our milder winters were due to these winds.

At every opportunity during these ascents, Mr. Glaisher had directed the spectroscope to the sun, and always saw a very fine spectrum with many lines, more numerous than on earth, and better defined. The spectrum usually extended from A to far beyond H. The spectrum was perfect with a much narrower opening of the slit than on the ground, and lines could therefore be clearly resolved which could not be seen from the earth. A blackened bulb thermometer, placed near another carefully screened, for determining the temperature of the air, generally read the same as the latter. No tinge of ozone was shown on the test papers in any of the journeys.

W. C.

Chemical Science. (Section B.)

In reviewing the proceedings of the Chemical Section, it should at once be stated that the interest attaching to the week's transactions lay not so much in the contributions formally presented to the meeting, as in the supplementary observations which were frequently offered by way of discussion upon the points raised in the authors' papers. The members of the Chemical Society seemed to have adjourned in a body to one of the spacious class-rooms of King Edward's School; and Dr. W. A. Miller, when delivering his inaugural address, was ably supported by Professors Frankland, Hofmann, and Williamson, and surrounded by many of those who commonly attend the *séances* at Burlington House. The place of meeting this year held out many inducements to the technologist; and the facilities afforded for the study of the leading industries of the great Midland Metropolis were fully taken advantage of; amongst those manufactories

which offered the greatest attractions for the chemist, may be particularly mentioned the Glass and Chemical Works of Messrs. Chance, the Phosphorus Works of Messrs. Allbright & Wilson, the Electroplating Factory of Messrs. Elkington, Mason, & Co., the Birmingham Gas Works, and the Iron and Engineering Works of Messrs. Lloyds, Fosters, & Co., of Wednesbury, where the process of converting cast-iron into Bessemer-steel was practically demonstrated. The excursion programmes provided ready means of visiting the objects of interest in the surrounding districts, such as the Burton Breweries, Worcester Porcelain Works, and the Potteries and Blast Furnaces of Colebrook Dale and South Staffordshire. Some special points of great interest in connection with the metallurgy of copper were shown at the Stephenson Metal Tube Works, Birmingham, and the effects of heat and pressure upon a variety of mineral substances were well illustrated in the "Patent Jet" and "Rock Jewellery" Works of Messrs. Dain, Watts, & Manton. The process of effecting the electro-deposition of brass, copper, tin, and other metals were likewise thrown open to inspection. These were, indeed, deemed of sufficient importance to be taken cognizance of by the President in his inaugural discourse, in the course of which, after alluding to the signs of progress manifested in the further development of the metallurgy of magnesium, thallium, lithium, indium, and other rare metals, they were pretty fully described. The exposition of the latest views regarding the chemical theory and nomenclature, and the progress made during the past year in several branches of organic research formed the burden of Dr. Miller's introductory statement.

The sectional proceedings commenced with the exhibition of a "New Form of Spectrum Apparatus as applied to the Microscope." Mr. H. C. Sorby described the instrument, and proved that by its aid suspected blood-stains on linen fabrics, &c., could be recognized by the production of dark bands occupying positions in the spectrum identical with those furnished by blood itself, seen by indirect vision at the same time in the field of the miscroscope.

Professor F. A. Abel read a paper, entitled "Notes on the Compounds of Copper and Phosphorus," in which he described certain definite combinations of these elements, but particularly referred to the beneficial effects of adding small proportions of phosphorus to melted copper or bronze; which metals, when so treated and cast in iron moulds, or "chills," offered very great resistance to tensile strain, and seemed applicable to the manufacture of heavy ordnance. Copper alloyed with 0·5 per cent. of phosphorus, supported 38,380 lbs. per square inch, whilst metal in which the proportion of phosphorus was augmented to 1·4 per cent., did not break until the weight amounted to 47,000 lbs. on the same area: this result being nearly double that representing the strength of the purest variety of commercial copper. In the course of discussion it was stated that the employment of phosphorus in the manufacture of wire for telegraphic cables could not be recommended, since the existence of the merest traces of the phosphide injuriously affected the electric conducting

power of the metal. Messrs. A. and H. Parkes, of Birmingham, appear to have been working for many years under a patent, in which the advantage of using phosphorus in order to secure a sound casting in copper is a special feature.

A communication "On Silicium in Iron," and two other papers of minor interest by Dr. T. L. Phipson, were read, and afterwards commented upon by several speakers. The general expression appeared to be adverse to the opinion advocated by Dr. Phipson, *viz.* that the physical characters of iron and steel are mainly determined by the state of combination of the silicium, which it is asserted may exist in the metal in two distinct modifications. Dr. A. Voelcker described an interesting specimen of *Boiler Deposit*, which was said to contain a considerable proportion of hydrate of magnesia in association with sulphate of lime. The same author likewise directed attention to some *Phosphatic Nodules*, lately discovered at Nant Gwynnant, North Wales.

Dr. Angus Smith exhibited a simple form of apparatus for determining the presence of carbonic acid in vitiated air, which he found particularly applicable to the testing of the atmosphere in factories and mines. An india-rubber ball, connected with a bottle holding baryta water, served, by passing through the liquid a definite volume of air to be tested, to indicate roughly the amount of carbonic acid present in the air. The point of first formation of an opalescence, or permanent precipitate, was that which guided the operator, after a few comparative trials, to a knowledge of the degree of purity or contamination.

Professor A. W. Williamson's report "On the Gases evolved from the Bath Waters," gave rise to an animated discussion upon certain difficulties of gas analysis, particularly the production of carbonic oxide whenever pyrogallic acid was used to absorb oxygen from a gaseous mixture. Dr. Crace Calvert, in a paper entitled "Notes on the Action of Acids on some Metals and Alloys," described the conditions under which zinc, copper, and brass are soluble in sulphuric acid of different degrees of dilution.

The preparation of a material called "Parkesine" was briefly described by Mr. Owen Rowland, and its use for coating telegraphic wires advocated on account of its great insulating properties. It was superior in these respects to gutta-percha, india-rubber, or ebonite. Dr. Finch described certain methods of "Utilizing Blast Furnace Slags," which were said to be practised in France and Germany. The waste material was cast in the form of huge rectangular blocks, which after being slowly cooled were trimmed by the mason and used for street paving. The presentation of the Report of the Committee on Gun-cotton was deferred until next year; Mr. Manning Prentice gave, however, a short account of the manufacture of Gun-cotton at Stowmarket, and described an improved method of preventing its decomposition by keeping it always moist. He recommended the use of Gun-cotton cartridges for sporting purposes, and stated the leading

advantages to be that of not fouling the barrel, whilst the piece when fired was subject to less recoil than in the case of gunpowder.

Dr. David S. Price read an important communication, "On the Action of Light upon Sulphide of Lead, and its bearing upon the Preservation of Paintings in Picture Galleries." The author found that the action of sulphuretted hydrogen upon lead-salts was greatly influenced by exposure to the sun's rays, and that recently-formed black sulphide of lead became bleached by conversion into sulphate whenever the light had access. Hence it was not always desirable to screen the face of oil paintings from the sunshine, but on the contrary, an old practice seemed to confirm the author's scientific conclusions, and he would recommend the occasional restoration of such works of art by freely exposing to the light any pictures which may be showing the effects of a tainted atmosphere.

A very interesting discussion followed the reading of Dr. T. Wood's paper, "On the New Formulæ, with reference to Schools and Examinations," the result of which lent authority for the general use of the new system as being at once more truthful and better adapted to the wants of the pupil than the old chemical notation. The President and Professor Williamson spoke strongly in favour of its general adoption, and urged the necessity of requiring its employment in all public examinations.

The crystalline forms of Melaconite and Tenorite were defined by Professor Maskelyne, and a most interesting account of certain minerals from Norway and other localities was furnished by Dr. David Forbes, who exhibited a collection of beautiful specimens in the Museum of the Midland Institute. "The Sanitary and Economical Aspects of the Sewage Question," and "The Utilization of Sewage, as conducted at Stroud," were treated of respectively by Dr. A. Hill (Borough Analyst), and by Dr. H. Bird, of Cheltenham, who coincided in advocating a return to a more primitive system of house drainage, an opinion which received the support of Sir John Bowring.

Messrs. Ladd and Oertling pointed out some important errors in the indications of the Sikes's Hydrometer, which seem to demand the attention of Her Majesty's Board of Inland Revenue. A new vacuum apparatus and Thermo-electric Pile were exhibited by Mr. William Ladd; a water barometer by Mr. Alfred Bird; and a variety of optical instruments by Mr. John Browning and Messrs. Powell and Leland, of London, and by Messrs. Field and Co., of Birmingham.

An interesting series of Photographs of the Interior of the Great Pyramid, taken by the aid of the Magnesium Light, were forwarded for exhibition by Professor C. Piazzi Smyth, together with a short statement of the difficulties encountered in their production, which, in the form of explanatory notes, was read by Mr. W. White. The collection of photographs included several views of the granite coffer in the King's Chamber, taken with measuring rods attached, and the author asserts that the real dimensions closely accord with those

adopted by the late Mr. Taylor, and that the cubical contents are precisely the measure of four English quarters of wheat. Professor Smyth seems to have found great difficulty in ensuring the continuous combustion of the magnesium wire, due partly to the deficient supply of oxygen in the interior of the Pyramid, for the ventilating passages opened by Colonel Howard Vyse in 1837 were found to have been completely stopped up with sand and stones by the Arabs; and further, the cloud of magnesium smoke required so long a time to deposit, that it was found impossible to make more than one experiment in the space of twenty-four hours. A very remarkable photographic effect resulted from the trial as an illuminating agent of a pyrotechnic mixture composed of magnesium filings and mealed gunpowder; and the before-mentioned views of the interior were supplemented by some excellent photographic representations of the principal external features of the Great Pyramid.

J. S.

Geology. (Section C.)

The business of this Section was opened by the address of the President, Sir R. I. Murchison. He specially enlarged on the discovery of organic remains in rocks of higher antiquity than those in which they were known to occur at the time of the last meeting at Birmingham, and yet he argued that the discoveries, instead of interfering with, sustain the truth of that doctrine that the lowest animals alone occur in the earliest zone of life, and that this beginning was followed through long periods by creations of higher and higher animals successively. As a striking example of the existence of a well-marked period beyond which no trace of a great group of animals has ever been found, he appealed to the existence of the remains of fish in the Upper Silurian rocks, and their entire absence in all of higher antiquity; years of careful investigation having made the negative evidence very strong, and leading us to conclude that there was a beginning as well as a progress of creation. Another point specially brought before the Section was the inadequacy of the modern intensity of existing causes to produce some of the phenomena of excavation and denudation, the author arguing that we cannot apply to flat regions, in which water has no abrading power, the same influence which it exerts in mountainous countries; and that we are compelled to admit that the convulsive dislocations of former periods produced many of those gorges in which our present streams flow.

The Association may well congratulate itself this year on the satisfactory results of explorations undertaken at its request, and aided by grants from its funds. None of them excited more general interest than the report of the committee on the explorations of Kent's Hole, Torquay, carried on under the superintendence of Mr. Pengelly and Mr. Vivian. Much still remains to be done, and no doubt will be accomplished by means of the additional grant made at this meeting. However, so far the results are of the greatest interest and eminently satisfactory. The inquiry has been conducted with the utmost care;

such a large amount of fossil bones have been discovered that it will be possible to supply most instructive series of specimens to the leading museums of the country, and the contemporaneous existence of man and various species of large extinct mammalia appears to be very well established. So far no human bones have been found, but a considerable number of flint implements of such forms that their artificial origin, through the agency of man, admits of no reasonable doubt. In connection with cavern explorations, we may allude to those undertaken in the caverns in Malta, under the superintendence of Mr. Adams. These have yielded, so far, the remains of two species of elephants, remarkable for their diminutive size—Mr. Busk having lately determined another species in addition to that described by the late Dr. Falconer.

Another report, not only of local, but also of great general interest, was that by Mr. David Forbes, on the igneous rocks of Staffordshire. One of the striking conclusions which we may draw from it, is that geologists ought not to rely so exclusively on mere appearances, but should pay more attention to the chemical analysis of rock masses. Studying them in this manner, the author concludes that all the different varieties of these rocks may have been, and probably were, derived from one simple source; and that the difference in their aspect was caused by the manner in which they were erupted, or by the extent of subsequent alteration or decomposition.

Another paper by the same author, "On the Existence of Gold-bearing Eruptive Rocks in South America," which have made their appearance at two very distinct geological epochs, corrected certain generalizations derived from the study of gold-bearing rocks in other countries, and was moreover valuable as showing that the gold was derived from the granitic rock itself. The author argued that the gold-bearing quartz veins were the direct continuation of the quartz of the granite, which had penetrated into fissures in the surrounding rocks, leaving the other constituents behind. In proof of the existence of gold in the igneous rock itself, he mentioned a case in which the decomposed granite is worked and washed to obtain the included gold.

In a paper "On Glacial Striation," Professor Phillips, the President of the Association, brought before the Section the question of the glacial origin of lakes. He argued that in studying this subject it would be well to apply more rigorous methods of research than those too often adapted; for it is a mechanical problem, capable of solution on accurate mechanical principles. Applying these to the special case of Wast Water in Cumberland, he contended that the amount of mechanical force due to the pressure of the ice existing in the upper steep part of the ancient glacier, would not be sufficient to effect the excavation of the lake in the lower and comparatively level part of its course.

A remarkable example of the light which ancient history and archæology may throw on certain comparatively modern geological phenomena, was furnished by a paper by Mr. R. A. Peacock. On

comparing early records with the present configuration of the coast of France and of the Channel Islands, the author concludes that most extensive changes have taken place during the historical period; subsidences, varying up to as much as 100 feet in some cases, having occurred over considerable areas, as shown by a large coloured map illustrating the subject. In a very analogous paper, by Mr. Pengelly, "On the Isolation of St. Michael's Mount, Cornwall," it was argued that subsequent to the occupation of the country by the ancient Britons, who called this "the hoar rock in the wood," but yet anterior to the period of the Romans (Diodorus Siculus, speaking of it as an island), the rock had been so separated from the main land as to be an island at high water. The author contended that separation had been effected, not by the encroachment of the sea, but by a general subsidence of the land.

Amongst the papers related to districts of which the geological structure is very imperfectly known, special reference may be made to that by the Rev. W. Holland on the Geology of the Sinaitic Peninsula. A most instructive collection of fossils was exhibited, including cretaceous and older forms, amongst which was a well-marked stigmaria. Some comparatively very recent deposits yield distorted varieties of cardium, and indicate that the Red Sea was more extensive, and that its waters were far less salt than at present, and similar to those of the Baltic.

Amongst the most striking palæontological discoveries brought before the Section was that of a fossil spider, from the coal measures of Upper Silesia, described by Professor Römer of Breslau. A new large saurian from the Wealden of Brook, Isle of Wight, was described by the Rev. W. Fox, for which the name Polacanthus has been proposed by Professor Owen, in allusion to the remarkable spine-like bones which ran along the sides of the body and tail. A number of new leaf and other forms from the plant-bed in Alum Bay, Isle of Wight, were described by Mr. W. S. Mitchell, amongst which were some well-preserved flowers. The interest attached to these beds has induced the Association to make a grant for their more complete exploration.

It is, of course, always desirable that at all meetings of the Association local geology should be well represented. On this occasion the Silurian, carboniferous, and Triassic rocks and their fossils, as well as the peculiarities of the superficial drifts, were described by Messrs. C. Ketley, S. Bailey, H. Johnson, W. Molyneux, C. Twamley, Rev. P. B. Brodie, and other local geologists. Though not forming part of the proceedings of the Section, we may class with these communications the lecture of Professor Jukes on the extension of the coal measures below the Red Rocks of the neighbourhood of Birmingham. The chief point impressed on the audience was the fact, that, though coal measures might exist at a great depth, it by no means follows that after sinking through a great thickness of rock any valuable beds of coal would be found. He particularly insisted on the necessity of anyone who undertook such a project

being prepared to carry it out in a thorough manner, since it was impossible to meet with coal measures except at a great depth; and he argued that a matter of such great national importance as the accurate solution of the problem, ought to be carried out at the national expense.

H. C. S.

Zoology, Botany, Physiology. (Section and Sub-section D.)

The business of Section D was opened by a few introductory remarks by the President, Dr. T. Thomson; and that of the Sub-section by an eloquent address by the President, Professor Acland of Oxford. Dr. Acland commenced by discussing the relation which biological science bears to medicine. He pointed out that its objects are unquestionably, 1st, simply to ascertain what are the facts in a certain department of nature; 2nd, how they may be made of value for the practical exigencies of mankind. So that however desirable it may be to have physiology cultivated by persons whose undivided attention can be bestowed upon it, yet that it is the special duty of the physician to promote the advancement of physiological knowlege to the utmost of his power. He argued that physiology was not a subordinate subject, but that it included a knowledge of the characteristics on which the classification of all living entities is based. He showed that the hindrances to a perfectly free study of physiological science arose, 1st, from the intrinsic difficulty of the subject; 2nd, from the prejudices of mankind. And he concluded by pointing out how important the cultivation of the subject is in connection with public health and practical medicine.

One of the earliest papers read was by Professor Lionel Beale, "On Vitality," in which he explained those views regarding the structure of organic tissues which are so intimately associated with his name, and which as they have been made known by him in so many quarters, it is needless for us to enter into here. He contended for the existence of a vital power distinct from the chemico-physical forces operating in the organism.

He was followed by Dr. J. H. Bennett, who advocated views regarding the origin of many textures opposed to that of Dr. Beale, and, taking the pus cell as an illustration, he stated that it did not arise within a pre-existing cell, but that it was produced by an aggregation of molecules in an exudation.

Various interesting questions connected with food and diet were discussed by Dr. John Davy. He considered that a diet of animal food was by no means incompatible with fatness, whilst on the other hand a vegetable diet did not necessarily tend to the production of fat. He expressed doubts of the accuracy of the theory, that if a man has not a given quantity of food, sufficient to sustain his physical powers, his health must necessarily suffer. He advanced various illustrations that a deficiency of food, though causing temporary weakness, did not produce any permanent ill effects, and argued that

the good diet of gaols really fed the prison population, and that therefore in them the lowest diet-scale should be used which would not necessarily engender permanent injury to the constitution.

The passage of Entozoa into the human body through eating impure food was discussed by Dr. Cobbold, who stated that beef infested by tape-worm larvæ was more frequently the source of that parasite than pork, whilst Dr. Fleming pointed out that the great prevalence of tape-worm in Birmingham was due to the consumption of measly pork.

Various points in the anatomy and physiology of the brain were treated of in these Sections. Dr. W. Dickenson read an elaborate paper "On the Functions of the Cerebellum," which was based partly on experiments on the lower animals, and partly on pathological observations. The general conclusion arrived at was, that the function of the cerebellum is to supply the voluntary muscles of the trunk and limbs with self-regulating motive power. Dr. Crisp, from a comparison of the weight of the brain in proportion to the weight of the body, in a number of animals which he had selected, came to the conclusion that the relative weight of the brain in proportion to the body was an indication of intelligence, for no animal with a relatively small brain possessed a great amount of intelligence. A description of the external form of the brain of the Orang was also given by the same gentleman. A discussion, "On Phrenology as an important Department of Ethnology," was opened up by a paper read by Dr. Prideaux, without however eliciting any new facts. Papers in other departments of human and comparative anatomy were also read. Dr. Humphry gave an account of the skeleton of a woman, aged 104, who had died from accumulation in the bronchial tubes. The cartilages of the ribs were as soft as in early life: the walls of the skull were unusually thick, and the skull weighed 27½ ounces, or 6 ounces more than the average. The thigh bone, on the other hand, was singularly light, and weighed only 5 ounces. Dr. Rolleston related the results of his observations on the body of a man supposed to be 106 years old. The skull in his case was so thin and soft, that it could be cut with a knife. Dr. Humphry also expounded his views on the homologies of the lower jaw and the bones connecting it with the skull in the Ovipara. He maintained that the several pieces of the oviparous jaw are represented by the articular and other parts of the mammalian jaw, and that the quadrate and quadratojugal bones are represented by the glenoid and zygomatic parts of the temporal of mammals. Dr. Rolleston described certain points in the anatomy of a fish, and a crustacean from the Mammoth Cave, Kentucky. He showed that the former possessed no abdominal fins, that the latter nearly resembled our own cray fish, only that it was more minute, and though it had been described as blind, yet a careful examination showed it to possess eyes, though these contained no black pigment, and had no facets at the corners. The same gentleman also described various features in the anatomy of Lumbricus terrestris, more especially in connection with the variability in the number of the rings and the arrangement of the muscular system and salivary

glands. An elaborate paper, "On Annelida from the Coast of Guernsey," was read by Mr. E. Ray Lankester. He had obtained about seventy-seven specimens, amongst which were three entirely new. The Rev. A. M. Norman described the structure and mode of development of the Salpa spinosa, as he had observed it at Guernsey.

Mr. William Turner gave the results of a number of dissections, more especially of the flexor muscles of the fingers and toes, and of the supra-condyloid foramen occasionally occurring in the human arm, from which he concluded that a great amount of variability was manifested in the construction of the human body in different individuals, that in the development of each individual, a morphological specialization occurs both in internal structure and external form, by which distinctive characters are conferred, so that each man's structural individuality is an expression of the sum of the individual differences of all the constituent parts of his frame.

Dr. W. H. Lightbody communicated a paper "On the Vascular Arrangements of the Cornea," in which he pointed out that the capillaries which extended for a short distance into that structure were enclosed in spaces, which, from the pale, rounded, lymph-corpuscular-looking cells they contained, he believed to be lymphatic vessels.

Dr. George D. Gibb refuted the view recently propounded by M. Guinier, of Montpellier, that in the act of swallowing the food came in contact with the vocal cords.

Dr. Richard Norris gave an account of a series of experiments which had led him to the conclusion that rigor mortis is not a contraction, either energetic or otherwise, of muscular tissue. It is a suspension of the property of extensibility, probably due to solidification (coagulation?) of a fibrenous (?) material, contained in the interfibrillar juices of the muscles, as asserted by Brücke and Kühne, the resolution of which, by incipient decomposition, restores to the muscles their mobility.

An elaborate report, "On Amyl Compounds and their Physiological Action," prepared at the request of the Association, was read by Dr. B. W. Richardson, and the committee of the Sub-section recommended a renewal of the grant to Dr. Richardson, in order that he might continue his researches on these bodies. The same gentleman also communicated a paper, "On Ozone," in which he summed up all the physiological facts which could be relied on respecting that body. Dr. Arthur Gamjee communicated the results of a number of experiments, which confirmed those of Kühne, that ammonia did not exist in the blood.

Mr. Stainton called attention to the fact that, out of eighteen species of the genus Laverna, no less than ten derived their nourishment, when in the larva state, from plants of the order Onagraceæ. Messrs. Westwood and Spence Bate discussed various questions relative to the Anceus, which they considered to be a distinct genus,

the Praniza of Leach being apparently the female anceus. Mr. E. Newton related the discovery of bones of Didus in the Island of Rodriguez. The Rev. F. Hewlett described various bones of the Moa, discovered in New Zealand, in the same oven as those of the Pig. Sir J. Lubbock described the metamorphoses of Ephemera (Chlæon).

Messrs. J. G. Jeffreys, A. M. Norman, and C. Spence Bate, gave in their reports of dredging expeditions in the Channel Islands, on the coast of Aberdeen, and on the marine flora and fauna of the south coasts of Devon and Cornwall.

Dr. Mörck read papers "On the Classification and Zoological Affinities of the Mollusca."

Mr. Frank Buckland made his report on oyster culture, in which he showed that the young spat preferred the following objects to cling to,—the shells of oysters, muscles, periwinkles, whelks, pieces of crockery, glass, tiles, tobacco pipes, iron, and wood, the first-named being those usually selected. The fascines or faggots of wood employed in some localities would not pay the expense of laying down.

Dr. P. L. Sclater gave an account of the birth of a young hippopotamus in the gardens of the Zoological Society at Amsterdam; and Mr. Thomas Moore, of the Derby Museum, Liverpool, described some improved methods of displaying birds in public museums, which he had introduced into that institution.

A report, "On Zoological Nomenclature," prepared by a committee, was read by Sir William Jardine. They had come to the conclusion that permanency of names and convenience of practical application were the two chief requisites, and they deemed it undesirable to disturb by any material alterations the rules authorized by Section D, at the meeting of the British Association in Manchester, in 1842.

An important resolution, respecting Section D and its Sub-section, was arrived at by the General Committee of the Association:—That in future years Section D be entitled 'Biology,' and that the Council be charged with making the requisite arrangements to subdivide it into such departments as may seem best fitted to ensure its practical working.

W. T.

Geography and Ethnology. (Section E.)

The geographical subjects which came before the meeting were of most varied interest. Commencing with Europe, there was a cluster of three papers on the Mont Blanc range of the Alps, contributed by Alpine climbers and geographers. The one of most scientific interest was undoubtedly that of Mr. A. Adams-Reilly, "On a recent Survey of the Chain of Mont Blanc;" although a paper by Mr. E. Whymper, the hero of the Matterhorn, "On the Ascent of the Aiguille Verte,"—a mere narrative of bold adventure,—seemed to have most attractions for the crowded audience assembled on the day the three memoirs were read. Mr. Adams-Reilly is now well known as the author of a much

improved detailed map of the Mont Blanc chain; he exhibited to the Section the large original drawing of his map; and his paper was descriptive of the various surveys which had been undertaken in the district, and the causes of the gross errors that existed in other maps, especially that published by the Swiss Federal Survey. The errors in their delineation of the chain arose from the fact that only a small portion of it belongs to Swiss territory, the rest being Sardinian, and the official surveyors of the two countries working at different times up to the summit of the ridges constituting their respective frontiers, produced maps which could not be fitted into each other. The Swiss in dovetailing the Sardinian map with their own made a most serious blunder, for their surveyors, in carrying their triangulation up the *eastern* side of one of the ridges on the Sardinian frontier, which had been already triangulated by the Sardinians on the *western* side, mistook the position, and inserted it on their map as a separate mountain chain. In doing this, and to reconcile it with the rest, it was necessary to annihilate four square miles of glacier, and to pull together into one two mountains which had previously stood apart, different in name, separated by a distance of more than a mile, and differing in recorded height by nearly 700 feet. Mr. E. Whymper, as related in his own paper, was the companion of Mr. Adams-Reilly in his survey during the summer of 1864. Their intentien was to have ascended the Aiguille Verte together, but the difficulties seem to have been too great; and it was reserved for Mr. Whymper alone, with two guides, Almer and Biener, to accomplish the feat during the present summer. The third Alpine paper was by Mr. G. S. Mathews, on the "Ascent of Mount Blanc, by the Glacier de Brenva." The author was highly complimented by Professor James Forbes, who made a few observations on the three papers, for having accomplished what had previously been deemed impossible; and for having added several facts of great topographical importance, during his ascent.

Turning to Asia, there were first two papers on Palestine: one, a "Report of the Results of Surveys relating to the Water Supply of Jerusalem," by Capt. T. M'Neill, and Capt. Wilson, C.E.; and the other, "On the Exploration of the Holy Land, as proposed by the Palestine Exploration Fund," by Mr. G. Grove, Secretary to the Fund. The first mentioned seemed to belong as much to Engineering as to Geography, but communicated several new and interesting facts relative to the physical aspects of the neighbourhood of Jerusalem. The authors explained the non-existence of rivers by the porous nature of the soil, washed down the steep hill sides by heavy rains, and accumulated in the valleys, for instance in the valley of Urtas, to the depth of at least twenty feet. The surface water sinks through this and runs in subterranean courses to a great distance. It was only by reconstructing the terraces of the hill sides which probably existed formerly, and thus preventing the soil from being washed down, that the ancient fertility of the land could be restored. Mr. Grove's paper was of the nature of an appeal for support to the scheme of exploration proposed by the Palestine Exploration Fund, which after a very

fair commencement seems now to require a fresh stimulus. In the interesting discussion which followed the reading of the paper, the Rev. H. B. Tristram spoke of the much better chance of discovering ancient Jewish remains, in retired country places than in the city of Jerusalem, where the Society intended to commence operations. He gave his own experience in Tunis as an example. Whilst there he was for some time the companion of Dr. Davis in his excavations on the site of Carthage. They had to dig through stratum after stratum of Roman and more recent remains before they reached a single Punic inscription; whereas in an outlying place at a distance from Carthage he discovered abundance of Punic remains by simply scratching the ground. He thought it would be similar in Jerusalem, and moreover the Romans used up old Jewish masonry in building their edifices. The best course the travellers employed by the Association could pursue would be to cultivate the good will of some semi-Fellahin tribe, who retained by tradition the names of ancient places mentioned in Exodus and Numbers, and set to work on the sites pointed out by them, which would probably be often some mound hidden in a wood.

Akin to the foregoing was a paper by Colonel Pelly, entitled "Notes on Arabia," which contained some few details not included in a former paper on his journey to the Wahabee capital, lately contributed to the Royal Geographical Society.

After an amusing anecdotical paper, "On City Life in Bokhara," by the Hungarian Dervish, Dr. Vámbéry, Sir Henry Rawlinson addressed the Section on the subject of the Russian Frontiers in Central Asia. He said that some few years ago the Russian boundaries extended from the northern shore of the Caspian Sea, by a long bend to the north, towards the limit of Chinese Tartary, and were separated on the south from the Khanats of Khiva, Bokhara, and Khokand—three countries which occupy the space between the Caspian and Chinese Tartary—by a wide region of Steppes, peopled by various tribes of Kirghises. A line of outposts, called the Orenburg and Siberian line, marked the course of this frontier. For many years their hold on the territory was but slight; and in 1847 they constructed three forts in order to strengthen it. They penetrated to the south of the Kirghis Steppe by sending a force in armed steamers up the Jaxartes river, which discharges itself into the Sea of Aral. The Steppe is traversed by few roads, but one of these is of great importance, extending from Orsk, north of the Aral, to the Jaxartes. It is traversible nearly throughout by wheeled carriages. By dint of gradual encroachments during the last few years, the Russians have occupied the whole of the Kirghis territory, and now their frontier extends along the Jaxartes to Fort Perofski, and thence through a part of the Khokand territory to the south of Lake Issyk-kul. They have thus advanced a thousand miles from north to south in the direction of British India, during the time that our own possessions have extended a thousand miles from south to north. The present distance between Peshawar, our real northern boundary, and the nearest point of the Russian frontier, had been ascertained lately by

our agents, who had traversed the distance, to be about one thousand miles; but the distance from the territory of our tributary Kashmir to the same point, is only from four to five hundred miles.

Passing to Africa, the first subject which came before the Section was the discovery of the new Nilotic Lake, Albert Nyanza, by Mr. Samuel Baker. It was a great disappointment to the meeting to learn that the adventurous explorer himself had not arrived in England, as it was expected he would have been present to give a fuller account of his discovery. According to his last letter he intended to leave Khartum on the 21st of June, so that some obstacle has intervened to delay his homeward voyage. His letters, the contents of which have already been made public in 'The Times' newspaper, were read to the Section, and a discussion took place on the relative values of his discovery and those of the late Captain Speke. A large diagram of Africa was also exhibited, on which the new lake (copied from Mr. Baker's own sketch-map sent home from Khartum) was represented in the position assigned to it by its discoverer. It appeared a little larger than the Victoria Nyanza of Speke, and lay to the west of it, running in a north and south direction, but with a long bend at its southern extremity to the west. It covers the Luta Nzige as represented on Speke's map, and also part of the smaller lake *Rusisi*, which Speke had heard of from the natives of Karagwe, and which evidently forms part of the same vast inland sea. The speakers, Sir Roderick Murchison, Mr. F. Galton, and Sir Henry Rawlinson, all agreed that the discovery confirmed the accuracy of Speke's map in so far as concerned the discharge of the waters of the Nile after leaving the Victoria Nyanza into another vast lake, but the President reminded the meeting that the fact of the exit from the lake of the Nile (or the river which flowed past Gondokoro), still remained to be settled by direct observation.

The only other paper on Africa was one by Mr. Thomas Baines, the artist-traveller, descriptive of the Victoria Falls of the Zambesi, which he visited in 1862, spending several weeks on the spot, surveying the district, and sketching and photographing the scenery. A large series of oil-sketches besides diagrams, and a model of the Falls, all the work of the author, were exhibited, and conveyed a far clearer idea of this wonderful feature of Central Africa, than had hitherto been possible. The cataract is produced by the river, at a place where it is a mile-and-a-quarter broad, dropping into a deep narrow chasm which stretches entirely across its bed. From this transverse cleft the waters escape by a narrow passage into a long zigzag gorge, which continues for several days' journey down stream. The height of the cataract is about 400 feet, and the width of the chasm from 70 to 130 yards. From the bottom a dense cloud, or series of clouds, of spray arise to the height of about 1,200 feet, and the perennial shower of scintillating water-drops give rise in certain aspects to brilliant double rainbows.

Two papers were read by Colonel Pelly, on islands in the Indian Ocean, and off the east coast of Africa: one, the Seychelle group,

and the other, the Comoros. The Seychelles, according to the author, are the summits of a group of granitic mountains surrounded by banks of coral, and consist of thirty islands, varying in size from a length of seventeen miles to islets containing only a few acres. The Comoros are larger islands, and four in number, one of which, Mayotte, is under French influence, they having a naval station on the islet Zaondzi, close to its shores. The Seychelles when discovered were destitute of inhabitants, but the Comoros were found to be peopled by an aboriginal race, of which scarcely any record remains, the islands having been for some centuries dominated by immigrant Arabs. Comoro proper, the largest and northernmost island of the group, is the least known, although the most remarkable in its physical features. Active volcanoes, 8,000 feet high, rise from its surface and pour forth streams of lava, which flood their flanks and rear or obliterate islands in the surrounding ocean. When the English consul, Mr. Sunley, recently visited the island, after an absence of four years, he found a lava reef, three quarters of a mile in length, jutting out near his old landing-place and perplexing his topography.

There was a short paper by Mr. Robert Swinhoe, entitled "Additional Notes on Formosa," and supplementary to a more elaborate paper, which he read at the Newcastle Meeting in 1863.

On Australia there was only one short paper, a sketch of the journey recently (in 1864) performed by Mr. Duncan McIntyre across the continent, from the Darling river to the Gulf of Carpentaria. This journey has excited great interest in Australia, owing to the discovery, by Mr. McIntyre, near the banks of the Flinders river, of supposed traces of Leichhardt. The traces consist of two trees marked with the letter L, and, from the age of the incision, believed to indicate a Leichhardtian camp; and of two old horses with half-effaced brands upon them, found straying in a region where no horses were ever left by any subsequent explorer. The geographical results of the journey were the discovery of a fine stretch of pastoral country,—smooth, undulating downs,—stretching from the stony desert of Sturt to the northern coast range, and of four new rivers north-west of Cooper's Creek. The journey from Cooper's Creek to the sea occupied only thirty-four days, a little more than half the time taken by either Burke or McKinlay. Mr. McIntyre's object was the discovery of a good route for stock to Northern Australia and the Gulf of Carpentaria, in which he appears to have succeeded. He found that no impediment exists to the construction of a carriage road or railway from the Darling river to the Gulf.

The question of North Polar Exploration was discussed in two papers having that title, one by Mr. C. R. Markham, and the other by Admiral Ommanney. Mr. Markham marshalled with great force the various arguments in favour of the Smith Sound plan, as proposed last winter by Captain Sherard Osborn, and already made known to the public. He quoted Sir Leopold McClintock as an advocate of this route, as the best for attaining the ends of a North Polar expedi-

tion, which are not simply to go to the Pole and back, but to explore, in the interests of various branches of science, the unknown area that surrounds the Pole. This could be done only by well-organized sledge parties, supported by two vessels stationed at a distance apart from each other. All the scientific societies of London which were invited by the Royal Geographical Society to co-operate with them in endeavouring to obtain the despatch of an expedition, were stated to have returned answers expressive of the great advantages to their respective sciences which would accrue. Mr. Markham adduced various known facts to prove that a sea voyage to the Pole, between Spitzbergen and Nova Zembla, as advocated by many, would be impracticable, and in this he was supported, in the discussion which followed the reading of the papers, by Mr. Alfred Newton, who had recently been in Spitzbergen, and stated that the Norwegian walrus-hunters had sighted land at various points between the two groups of islands, and had proved that they were connected besides by an impassable barrier of ice. The arguments in favour of the adoption of the Spitzbergen route by an English expedition had now lost much of their force, as a German expedition was being organized at the invitation of Dr. Petermann. A pioneer vessel despatched from Hamburg a few weeks ago had broken down soon after leaving port, but it was intended to renew the attempt next year. It behoved English geographers therefore, as the Spitzbergen route was now pre-occupied, to concentrate their endeavours on the obtaining of an expedition to penetrate *viâ* Smith Smith.

A short paper, "On Explorations in the Interior of Vancouver's Island," by Mr. Robert Brown, narrated the various journeys performed by an expedition despatched by the Vancouver's Island Exploration Committee, under the leadership of the author. Numerous rivers, lakes, chains of mountains, coal beds, and gold diggings were discovered, but the interior of the whole southern half of the island was found to contain very little land adapted for pasture or agriculture. Travelling southward, along the continent of America, the next paper was one by Dr. Cullen, "On the Isthmus of Panama and Interoceanic Ship and Canal Routes;" who also contributed an Ethnological paper, "On the Darien Indians." The Panama paper described all the various routes which had been proposed for a ship canal from ocean to ocean across the narrower parts of America, ending by advocating the Darien route, or that between Caledonia Harbour, on the side of the Atlantic, and the Gulf of San Miguel, on that of the Pacific. The last Geographical paper to be named was "On the Ascent of the River Purus," by Mr. William Chandless. This was stated by the President to be, in a geographical point of view, the most important one which had come before the Section; but owing to its length, and the shortness of the time for the Sectional business, only a few extracts could be read. He said, however, that it would form the subject of one of the evening meetings of the Geographical Society in the ensuing session. Mr. Chandless appears to be an English gentleman travelling for pleasure in South America, who, hearing of the failure of a Brazilian expedition to ascend this

most important branch of the Amazons, in which, according to native report, there existed no impediment to navigation, resolved to attempt its exploration himself. Besides the importance of the Purus as a prospective channel of communication between the Atlantic (*viâ* the Amazons) and the rich southern provinces of Peru, east of the Andes, it has been for many years an object of great interest to geographers, owing to the mystery connected with its source. Its head waters have been presumed to be the river Madre de Dios, which flows from the Andes, in Southern Peru, and is supposed to be the seat of retirement of a large number of Inca Indians, who have effectively resisted all the attempts of white men to descend on its waters. Mr. Chandless ascended the Purus from its mouth a distance of 1,866 miles, and did not reach its source, but found it dwindled to a rivulet, lying 2° to the N.N.W. of the Madre de Dios. He met with tribes of Indians who had never had intercourse even with the semi-civilized tribes, and has constructed a complete map of the river from astronomical observations and compass bearings.

The Ethnological papers, as we have already hinted, were some of them of a Philological cast, some Anatomical, others Geological and Archæological, others even Historical, and the residue only purely Ethnological. The Philological series were:—1. "On the Origin of the Hungarians," by Dr. Vámbéry, an argumentive paper, proving, from a careful comparison of the grammatical structure of languages founded on the author's original observations, that the Hungarians are descendants of the Turco-Tartar nations dwelling in the western part of Central Asia; 2. "On Language and Ethnology," by the Rev. Mr. Farrar; and 3, "On Negro-European Dialects of the Negroes of Surinam and Curaçao," by Mr. E. B. Tylor. This last was an investigation of the curious, degraded idiom, compounded of various European languages, which has been developed amongst the isolated Negro populations of the countries mentioned; and from it the author deduced the conclusion that Philology was not a reliable guide in the affiliation of races. The papers of Anatomical aspect were, one "On the Influence of Civilization upon the Cerebral Development of the Different Races of Men," by Mr. R. Dunn; and another, "On certain Simious Skulls, with especial Reference to a Skull from Louth, in Ireland," by Mr. C. Carter Blake. The last-mentioned related to a modern skull, recently found at Louth, which bore a strong resemblance to the celebrated Neanderthal cranium; and it was shown that the contracted forehead, and other characters which had led some writers hastily to infer simious affinities in the Neanderthal skull, were due, as in the Irish specimen (exhibited to the meeting), to the premature closing of certain sutures. Of the Geological and Archæological papers in this Section, our limited space will not allow us to speak; besides, they come more properly under the Geological Section.

H. W. B.

NOTES AND CORRESPONDENCE.

On the Probable Conditions (Past and Present) of the Lunar Surface.
By T. Clifford Allbutt, M.A., M.B., Cantab.

I LATELY took up the number of your Journal, published in January last, and in it I find a letter from Mr. Nasmyth, in which he speculates on the vast antiquity of the lunar surface. By it I was reminded of a previous communication by Mr. Nasmyth on a like subject, which was accompanied by a most admirable lithograph of a portion of the lunar surface. As I read these remarks certain speculations, which I have long entertained, rose in my mind, and I now offer them to you for what they may be worth. Mr. Nasmyth says in his letter of January, that "the moon in all reasonable probability never possessed an atmosphere or water-envelope." He said, also, in his former communication (which I find in your number for July, 1864) that the moon is not necessarily a "useless waste of extinct volcanoes," although it be "unfitted for animal or vegetable existence as known to us," &c. &c. In these and in many similar places Mr. Nasmyth does but speak as all competent astronomers speak of the moon, as being now a hideous waste, airless, waterless, and lifeless; and as having probably been so always. Now, sir, I cannot but take a view, which to some degree differs from this. As regards the present state of the moon, I am in full agreement with Mr. Nasmyth and other admirable observers whom I trust far better than I trust myself. I differ with them in regard of their inference as to the past states of the moon. I may be allowed to quote from Mr. Nasmyth's first paper, the following line, "particles, originally existing in a diffused condition, were by the action of gravitation made to coalesce and so to form a planet." It will be seen on reference that he thus speaks in explanation of certain volcanic phenomena common to the moon and to our own planet; and that he speculates on their common origin and similar development. The consequents which we find in the moon being so far almost identical with those which we find in the earth, we are justified in expecting that the antecedents were also identical, or nearly so.

I am glad to have this common starting point, and these common results, from which I may ask Mr. Nasmyth to pass to a consideration of transition states.

Now, sir, no discoveries have interested us more than those by which we have learned that the constituent elements of our own planet correspond in great measure, if not thoroughly, with those of other heavenly bodies. These discoveries justify a presumption that the moon, which as a mass of matter lies adjacent to us (and has even by some been supposed to have been ejected or detached from our own planetary mass at some early period of consolidation), consists of elements the same, or nearly the same, as those of which the earth consists. We should then further presume that, if subject to like conditions, the mass of the moon would also tend to pass through stages of existence corresponding to those of the earth. Some of those conditions, however, are widely different, as, for instance, the relation of volume to superficies, the power of gravitation, and some others. Still

these differences are such as to affect the periods of the moon's development, rather in degree than in kind; in time, for instance, or in intensity. May we not therefore reasonably suppose, when the mass of the moon had only cooled down to the state in which the earth now is, that at such period of her existence the relative densities of the various component elements, one with another, might resemble those which we now see on the earth; and that certain of them might then exist in a fluid or gaseous state, and form such watery and atmospheric envelopes as we possess? Owing to the small mass of the moon, this stage would be of much shorter duration than with us, but are we not bound to assume, in default of proof to the contrary, that it has been traversed? Our paltry experiments can give us but a feeble conception of the results of the intense cold of the now shrunken and burnt-out mass; but it is quite in analogy with them to suppose that those limits may be passed within which elements can exist as fluids or gases. It is indeed, *à priori*, unlikely that the moon should now possess such envelopes. We must remember that the fluid and gaseous states are but states of relative densities, and do not inhere in the nature or constitution of any particular element.

I would now ask permission to pursue these speculations a step farther, to carry them on from the physical to the possible vital endowments of the moon. The present want of life upon the moon is even more certain than the want of air and water: but must this have always been so? To repeat my former suggestions, I may say that the mass of the moon must in cooling have passed through a temperature more or less fitted for certain forms of life. Its constituent elements, moreover, being in all likelihood similar to our own, we may well conceive that they would develop into similar combinations*; that is, into combinations fitted for the support of life.

If such combinations existed, we have no reason to conclude that the gift of life was withholden from the moon; or if life be looked upon simply as a product of planetary change, we have every reason to suppose that it would find its place in the weaving together of the moon's processes. I cannot then help looking upon the moon, now cold and dead, as having once passed through the bloom of life, that bloom which will one day pass away from this beautiful earth when all we who dwell in it are beyond its gates. On the other hand, I would not have it supposed that I overlook the many difficulties which oppose me, such, for instance, as the peculiar aspects which the moon bears to the sun.

Nor do I ask that the moon may be regarded with certainty as a depopulated world; I only ask whether the probabilities from analogy are not strong enough to make us pause before we speak unhesitatingly of the moon as of a body blasted from its birth. It may be urged against me that my speculations are too fanciful, and that mere dreaming of possible pasts is no gain to science. I should reply that I did not initiate the dreaming process. It is not for me now to assert, though it may well be asserted, that any speculation on the past history of heavenly bodies is full of gain to science. All I have now to do is to offer one inference in place of another, to show that in this argument from the known to the unknown, two solutions at least are possible, and to show if I can that one is more probable than the other. With my apology for intruding so far upon your space, I remain, sir, yours faithfully,

T. CLIFFORD ALLBUTT,
Physician to the Leeds Infirmary.

Leeds, *Aug*. 28, 1865.

On Petroleum Springs in the Eastern Crimea, and on the Shores of the Sea of Azof. By Professor D. T. Ansted, M.A., F.R.S.

Among the many sources of supply that the demand for illuminating and lubricating oils has brought into notice, there are some that have been known to half-savage races from time immemorial, and actually used for similar purposes to those for which they are now applied. Some of these, though hitherto neglected, are both abundant and important. The shores of the Caspian Sea where the perpetual fires of Baku have been objects of pagan worship for at least two thousand years, and some islands of the Caspian where naphtha springs yield a yet larger supply, are well known instances. These places now supply petroleum and oils, such as we call "paraffin oil," to a great part of Asia Minor and the south of Russia. Conveyed by water to Astrakhan, and thence by the Volga, they reach Nijni Novgorod and are carried to Moscow. Conveyed by land across Georgia, the prepared oils are used almost to the exclusion of every other kind of illuminating material at Teflis, now a large and important city, and there seems no limit to the quantity that could be used even at a very high price if the supply were sufficiently large. At various places, as near Teflis itself, there are petroleum springs, but they are not available, as the rock oil cannot be used without distilling, and there is no apparatus for that purpose. Still farther west, at the extremity of the great chain of the Caucasus, there is a large and remarkable district, more than a hundred miles from east to west, commencing with the delta of the Kuban and the peninsula of Taman, and ending in the Putrid Sea, remarkable throughout for those curious phenomena known as "mud volcanoes" or "salses,"—some in an active state, and some recently extinct,—for springs of mineral water loaded with sulphur, sulphuretted hydrogen, nitrogen, and other gases, and for wells of petroleum, either with or without water.

These latter are far too important in the present state of the oil market to be matters of indifference. Wherever petroleum can be obtained of tolerably good quality, and in tolerable abundance, not too far from a place of shipment, it will of course attract attention. Oils from certain deposits near Kertch, in the eastern part of the Crimea, have already been shipped to England, although the local demand will probably prevent any great exportation, even if the quantity raised should be very much larger than it has hitherto been.

The Crimea is by no means inaccessible, and even the extreme ports of the sea of Azof, Berdiansk, and Taganrog are well known to all interested in the bringing of corn from the vast steppes of Russia to the English market. The sea of Azof is approached by the somewhat shallow straits of Kertch, the ancient Cimmerian Bosphorus, a passage between the peninsula of Kertch, a long straggling tract of land terminating the Crimea to the east, and the peninsula of Taman, an equally long and much more straggling land projecting from the western extremity of the great Caucasian chain, and containing the low swampy delta of the river Kuban, which is the main stream conveying the water falling on the northern watershèd of the Caucasus. The upper part of the Black Sea where it enters the sea of Azof is shallow, and the sea of Azof itself has nowhere more than a few fathoms of depth. Older tertiary rocks covered by tertiaries of newer date are here the only rocks to be seen, but they are often much altered, though the country is either a dead level, or consists of rolling ground, formed by the removal of beds of hard limestone, by denudation probably after fracture, and by

the scooping out of wide, shallow valleys originally formed by faults and small elevation axes. The only exception to this state of things, is when conical hills, detached or grouped, rise up out of the plains and present the curious appearance of mud more or less liquid, welling slowly from an orifice in the ground, forming hillocks by the material erupted, and allowing of a slow escape of certain gases, of which nitrogen and sulphuretted hydrogen seem to be the most frequent.

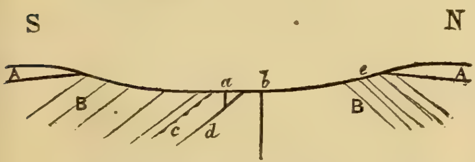
In a visit I have recently paid to this part of the world, I have been greatly interested by the mode in which these mud volcanoes are connected with petroleum wells, and by the essential difference that seems to exist between the conditions under which petroleum is found in the United States and Canada, and those met with in the East. In the former, as is well known, large quantities of oil are tapped, as it were, in the interior of the earth, where stores of this mineral exist under heavy pressure, and where it is kept down by beds of limestone or sandstone more or less nearly horizontal. Once tapped, the pressure causes the oil to rise up to, or even far above, the surface, just as water rises in an Artesian well. The petroleum obtained in the Crimea differs greatly in the circumstances of getting it, owing to the total difference of the geological conditions of the rocks. In its general nature it is, however, quite similar. The oil is found only at the bottoms of wells, into which it rather oozes than pours from the natural stores in the interior of the earth, whatever and wherever they may be. The Tatars—the old inhabitants of the Crimea—have sunk innumerable small wells, of which the indications may still be traced, and from the position of these may be obtained an idea of the nature of the sources of supply. The wells thus indicated are almost without exception in narrow bands, extending often, but not always, along the axis of east and west valleys, midway between the limestone cappings to the north and south.

The petroleum springs of the Crimea are entirely confined to the eastern part of that land, and almost entirely to the peninsula of Kertch. There are several very well-marked belts of country in which wells sunk a few yards into the soil yield more or less naphtha of very fair quality, and in most cases these have long been known and worked, though only to a very small extent. During the early part of spring, and also in the early part of summer, the position of the petroleum is considered to be marked by lines of different colour to the rest of the soil. In the early part of the spring these lines are greener, and in the early summer they are yellower than the rest of the land. This, if it can really be depended on as a useful guide in the discovery of fresh sources of supply, must be due to the influence of the oil on the soil where the naphtha crops out. The whole belt of land containing mineral oil is considerable, reaching across from the sea of Azof to the Black Sea as far as Arabat and Kaffa, and it may extend even farther to the west in the steppes. Beyond Arabat there are, at any rate, numerous springs of petroleum, as well as of sulphuretted hydrogen, in the Putrid Sea, whose name is derived from the oppressive smell of rotten eggs that pervades the whole atmosphere in this curious expanse of saline water. It is probable that the supply of mineral oil is both very large and very near the surface in many parts of the country where the geological conditions are favourable.

While examining the most productive and most remarkable of the naphtha-yielding springs, I was struck with their marked relation to the structure of the rocks, the existence of faults and anticlinal axes, and the numerous and systematic groups of mud volcanoes

and salt lakes that meet one at every turn in this curious country. It must not be supposed, however, that all the innumerable conical hills and hillocks seen in the Eastern Crimea are of volcanic origin. It is as certain that a great many are of purely artificial origin, as that others are natural, and built up entirely of mud. Nowhere, for instance, are tumuli so common, nowhere are old cairns more systematic, and nowhere have real hills been more curiously encased and cut into definite shapes by ancient peoples who once inhabited these lands. But nowhere, also, is it easier to recognize the little cone derived from the slow outpouring of soft mud, and distinguish the natural crater of an extinct volcano, though it may now be a pool of rain water.

FIG. 1.—*Section across the Valley of Beshevli.*



A. Limestones nearly horizontal.
B. Shaley clays dipping 45°, but in opposite directions on the two sides of the valley.
a. Pits to the oil-bearing bed *d.*
b. Boring down 500 feet in clays.
c. Bed of iron oxide.
d. Oil-bearing bed.
Horizontal Scale—One inch to a mile.

As a general rule, the petroleum wells are at some little distance from the mud volcanoes and the salt lakes. One of the most remarkable groups is that of Beshevli, about fifteen miles west of Kertch. The valley in which the springs are found is of considerable length, running east and west. A section across the valley at a place where several natural sections show the structure is given in the above diagram. A well-defined band of nodular clay ironstone (*c*), some inches thick, is seen in a small ravine, dipping 56° SSE. About 60 yards to the north, at *b*, is a rotten bluish clay, cropping out at the surface, loaded with naphtha. Into this clay a hole dug two feet rapidly becomes filled with naphtha to a depth of some inches, and on reaching this clay, by wells dug from 20 to 50 feet, very uniform and important supplies are produced. Some of this naphtha is of a deep-green colour, thin and transparent.

The oil-bed at Beshevli crops out along a line more than a mile in length in the valley of the same name, and probably extends farther, in both directions, than it has yet been proved. Numerous old wells, dug by the Tatars, are to be found along the line, and I counted upwards of twenty modern sinkings, varying from a few feet to about 50 feet, all of which had been more or less successful. Many others, sunk at a little distance from the line thus marked, and to a much greater depth, were failures. One in the lowest part of the valley (*b*), bored 500 feet to the north, a little beyond the crop, yielded no trace. About half a mile farther to the north there were springs so loaded with sulphur, as to coat the water with a film to a great distance, and cover all the rocks in the neighbourhood. At the place (*e*) where these springs come out, limestone overlies the rotten clays, shales, and ironstones unconformably. The rock itself that yields the sulphur, dips heavily to the north, and thus shows the presence of a fault or anticlinal axis in the valley, between *a* and *e*. There was everywhere proof that near the place where the belt of naphtha wells is traceable, there was a change of dip marking local disturbance and displacement of the strata.

Although the petroleum springs of the valley of Beshevli have not actually been traced more than about 2,000 yards from east to west, there are, as I have already mentioned, good indications of the continuance of the same condition

of the rocks for some distance. The valley, however, terminates some distance beyond the last well, and the limestone conceals the oil-bearing beds for another two miles, after which there are strong sulphur springs in a cross valley between the valley of Beshevli and the coast range of limestone. Beyond this are the waters of the sea of Azof.

Another remarkable and interesting petroleum spring is within a few miles of the town of Kertch, to the south-west; and here also the geological conditions are both curious and instructive. In a valley running westwards into the country, but not opening from the sea, enclosed between hills capped with limestone, one of which is very celebrated in ancient history as the tomb of Mithridates, there is seen a conical hill with a large crater open on the side towards the north, and on approaching the hill the opening is seen to resemble another valley, and to contain other much smaller cones of various size, some extremely perfect, and one perhaps 50 yards in circumference at the base. Close to the base of this cone, to the west, a well has been sunk in rotten clays and shales, sandstones, and nodular masses of iron, all dipping about 70° to north. In this well oil was reached at 17 feet, at a bed overlying the nodular ironstone. From 17 feet to 60 feet there was always some oil, and at 60 feet a band of sandstone was cut through. This rock was saturated with bitumen, and below it petroleum came into the well with great rapidity. Three feet lower the ground was so soft and tough as to rise up and render any further sinking impossible with the means at hand. A bore was then put down, and the oil stood at 6½ feet above the bottom of the bore at the time of my visit, and was replaced very rapidly when removed. The naphtha raised was of excellent quality, and remarkably clear and pure. There was no water whatever in the well or boring.

The ground where this well was sunk is about 100 feet above the level of the Black Sea, measured by a good mountain aneroid. About 50 yards to the south is an active mud volcano, and several small cones resulting from the eruption of mud are to be seen in an east and west line from this point. Some of them are at a considerable distance, and besides them sulphur springs appear both to the east and south. A very few yards beyond the line of the mud volcanoes to the south several borings have been made, but no trace of petroleum has been found.

Other borings nearer the well have shown a trace of oil, and a strong bituminous odour was found to characterize all the strata, but no sinkings have been successful that have not reached the sandstone. There can be no doubt that the source of supply of oil in this case is limited to the line of strike of a certain stratum, and it is more than probable that here, as at Beshevli, there is a reversion of strata and an anticlinal axis close by. At this point, however, I was unable to obtain proof of the axis by independent observation, for though the limestone capping the shales dips to the south, the shales are quite independent of these limestones. The existence of the line of mud volcanoes is however sufficient to justify the assumption that there is a fault or fissure communicating with the seat of chemical changes and operations in the interior of the earth.

A remarkable instance of petroleum springs is to be found on the shores of a salt lake some ten miles to the south of Kertch, close to the line of coast. The lake is large but shallow, and its level is a few feet below that of the Black Sea. It is called 'Tchongolek.' It is separated from the sea by a low bank of shelly sand a few feet above the highest level of the Black Sea, so that there is at no time free communication between the two waters, and the level of the lake is permanently below that of the adjacent open sea by at least

five feet. A cliff of shelly calcareous sandstone, of considerable hardness and from thirty to forty feet high, containing exclusively the shells of common species still inhabiting the Black Sea, exists on the north side of this lake, and is of some extent, since a road is worn or cut through it by which the lake is approached. The lake is very salt, and its waters are largely evaporated for the manufacture of salt for local use. It is evident that the lake has been much reduced in this way, for there is a level tract of nearly a quarter of a mile of mud between the banks and low cliffs that enclose it and the present water. The lake is pear-shaped, about two miles across in most parts, but there is a kind of inlet opposite the sea running another two miles into the country, and, perhaps, sometimes receiving a small amount of local drainage. On the south side of this lake (at *a* in the chart, Fig. 2) one is struck by

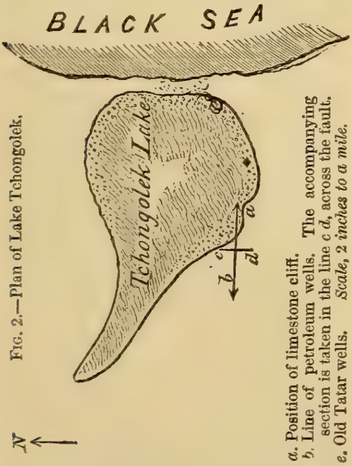


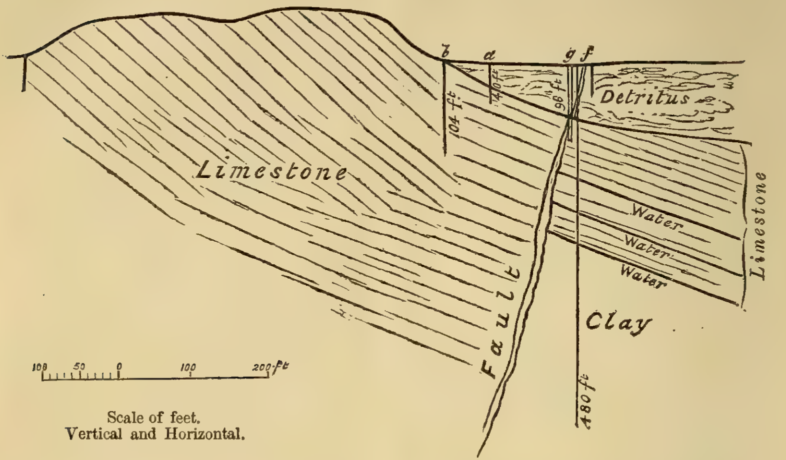
Fig. 2.—Plan of Lake Tchongolek.

a, Position of limestone cliff. *b*, Line of petroleum wells. The accompanying section is taken in the line *c d*, across the fault. *e*, Old Tatar wells. *Scale, 2 inches to a mile.*

the conical form of a part of the shore, and the appearance of a large semicircular space like an amphitheatre 300 yards across, scooped out and open towards the east. This is a hill of marly and shelly limestone, with gypsum, soft when weathered but very hard in the inside. Towards the east and north these rocks form nearly vertical cliffs 60 feet high, the rock pitching more than 45° to the north on the north side, and more to the west on the east side.

Just beyond the foot of these limestone cliffs to the north there is a line of petroleum springs. These are made known by the bubbling up of gas, accompanied by mineral oil, through the mud and water of the lake. They are also clearly indicated on the banks of the lake by a number of old Tatar wells, which range nearly east and west. Close to some of these old wells, and in various other positions, wells have been sunk and borings made in modern times. These vary in depth from 30 to nearly 500 feet. Some are through small depths of limestone into clay, others through surface accumulations to limestone, others through limestone only. Only some are successful, and the general result is that the petroleum must rise through or very near to a fault of considerable magnitude, which has thrown up the limestone to the north, on which side they have been denuded and their thickness much diminished. Where the fault is cut is apparently the place where most petroleum issues, and where after this the limestone is pierced, as in one of the wells, the supply of oil is diminished, and it comes up mixed with a good deal of water. The section in the next page will illustrate the nature of the case, and is proved by a number of sinkings, of all of which I have the particulars. Borings on either side of the line of fault have failed to reach anything more than the merest indications of naphtha. In this case there cannot be a doubt that the petroleum issues from a fault or line of fracture, but there is no mud volcano in the neighbourhood, and no volcanic indication of other kinds. The rocks around are chiefly limestones, but with some of them gypsum is largely intermixed. The clays reached in the deep bore were apparently of the same nature as

Fig. 3.—*Section across part of the Shore of Lake Tchongolek.*



those that generally yield petroleum in the district. The dip of the clays there are no means of determining.

On a continuance of the line of this fault as marked by petroleum wells, there are other wells at various points to the west to a distance of about two miles. The waters of the lake also show bubbles of gas with petroleum rising at some distance from the shore, far beyond the last well to the east.

There are at least half-a-dozen other distinct localities, within 30 miles of Kertch, in which naphtha has been obtained by the Tatars in old times, as shown by their lines of wells, and also by modern sinkings, none of them very deep. All are characterized in the same manner. All occur in valleys, and the strata through which the petroleum rises are always highly inclined and generally much disturbed. They are always the marls and clays of the lower series, over which the limestones with few exceptions lie unconformably. The direction of the belts of ground yielding petroleum, of the principal lines of elevation of the district, and of the lines of direction of the mud volcanoes, are all approximately the same, and there are springs of mineral water that appear to have a similar bearing.

I think there can be no doubt that throughout the whole petroleum district, extending from the eastern shores of the Caspian Sea to the Carpathians, a distance of more than fifteen hundred miles from east to west, there must be similar causes at work to produce effects so identical as those obseved. At intervals, which, it is true, are of considerable length, but always in rocks of the same kind, and of the same geological age, always, that is, in clays and marl of middle or older tertiary date, there are certain bands or belts of highly-inclined and fractured strata, through which mineral waters, mud, or petroleum occasionally issue. These are all strictly connected with the last great elevations to which the lands of the pre- and post-glacial epochs are due. All those lands, whether actually then above the water or only shoals rising slowly to form the vast steppes and plains of Asia and Europe, are due

to the action of disturbing forces, which, in other ways and other places, have poured forth floods of molten rock upon the surface, or beneath the sea have thrown into the air gases, smoke, and fine dust to cover and influence the earth, and have shaken, by systematic convulsions, the part of the crust of the earth too tense or too well defended by overlying masses to be broken asunder. Mountain chains have been lifted up both to the north and south of the great axis of elevation, and within open spaces formed in the rocks there has been at certain points a considerable amount of chemical action, resulting in the eruptions from volcanoes and the issue of mineral waters.

It will always be a question of great interest whence the carbon was obtained for the manufacture of those hydrocarbons, of which petroleum is one, and those gaseous emanations, in which carbon forms an important part. There can be no doubt that in the great majority of cases in America and Canada, the carbon has previously been accumulated by vegetable or animal organisms, buried under favourable circumstances, and retained during successive ages, until an outlet is found whence they may once more come to the surface. It is, however, equally certain that such accumulations as the great pitch lake of Trinidad, and some others less extensive, cannot be traced to have a history of this kind, and thus the question remains open. It is a matter of some interest that lignites consisting of vegetable matter in a state of only partial metamorphosis, have been found in the tertiaries on the flanks of the Caucasus, not far from Anapa, and also in the Carpathians. Similar accumulations, of very large proportions, are well known in other parts of the great expanse of middle tertiaries east of the Alps. It remains, therefore, possible, though there is as yet no proof obtainable on the subject, that the petroleum wells of the Crimea are connected with old accumulations of vegetable carbon. The fact is worth recording, that it may be proved or disproved in the particular case.

Speaking chiefly of the oil wells and oil supplies, I have said little of the mud volcanoes and the salt lakes. Both are peculiar, and in the highest degree interesting in reference to the oil supply. The vicinity of the mud volcanoes to petroleum springs, is very marked in one of the cases I have described, and the presence of numerous small wells in the line of mud volcanoes, beginning with those of Taman and crossing the northern end of the peninsula of Kertch, is suggestive. Petroleum is also found oozing through the earth and rising to the surface of the water in the neighbourhood of Tchongolek. Sulphur springs, of which the water is so loaded with sulphur as to cover with a film every surface over which it runs, and leave a thick scum on the water as it runs away into the valleys, are by no means rare within a few hundred yards of well-marked lines and belts of old wells. Here, again, there is an evident tendency to volcanic origin in the whole of the phenomena. As it is well known that the volcanic fires have only recently become extinct in all this neighbourhood, and as volcanic rock of modern date is extremely abundant at some little distance to the south of the central part of the Caucasus, covering with only occasional small exceptions a lenticular space six hundred miles in length and two hundred miles wide in the widest part, it need not excite astonishment that there should be important incidental results of this energy. The volcanic centres must be deep-seated, compared at least with any ordinary thicknesses of strata, but the work of nature in this part of the world has been on a very large scale in recent times and chiefly in the work of reconstruction, lifting up the wide tracts of sea bottom into plains and even

mountains, at a rate that may be slow enough in one sense, but which has been much more rapid than the effect of weather and water in wearing away by denudation all evidence of the work done. Thus it is, that the appearance and nature of the rocks, and the nature of the scenery in Eastern Europe and Western Asia are eminently characteristic of the most recent of the operations that have been continually going on, but which are masked and lost in Western Europe, where there has been far more denudation than deposit, and where the tertiary rocks are comparatively unimportant.

As a general conclusion to these remarks, on the naphtha springs of the Crimea, I would point out that their value and importance are to be estimated only when they are viewed as parts of a whole, and as among the results of volcanic action on a very large scale in very recent times. I think no one can study the evidence I have here brought forward,—I am sure no one could examine the phenomena on the spot,—without being struck with the mutual relation of the oil springs, the mud volcanoes, the sulphur springs, and the general form of the country. The same may be said with regard to the whole expanse of volcanic country from the south shore of the Caspian, to midway along the south coast of the Black Sea. It is only by considering the pheuomena as a whole, that they can in any way be understood, and thus I have ventured to generalize and connect rather than to give a mere detailed account of the particular points examined.

D. T. Ansted.

Athenæum Club, London,
August, 1865.

The Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot. (Correction.)

I should feel much obliged if yon would kindly, in your next 'Quarterly Journal,' correct a rather serious error which has crept into the appendix to the 'Report on the Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot,' by Mr. King and myself, and which has been perpetuated in the very complimentary review given in your April number.

The number of tons of charcoal required to smelt a ton of the magnetic iron is 3¼, and *not* 13¼, as stated in the Report (p. 161) and copied into the review (p. 343).

R. Bruce Foot,
Geological Survey of India.

Yercand, Madras,
July 11, 1865.

Books received for Review.

From *Messrs. Longman & Co.*:—

Manual of Geology. By Rev. Samuel Haughton, M.D., F.R.S., Professor of Geology in the University of Dublin. With 66 Wood Engravings. 370 pp. Fcap. 8vo.

Ice-Caves of France and Switzerland: a Narrative of Subterranean Exploration. By Rev. G. F. Browne, M.A., Fellow of St. Catherine's College, Cambridge. With Engravings. 320 pp. Demy 8vo.

Practice with Science; a Series of Agricultural Papers. Part I. 252 pp. Demy 8vo. With Engravings

The Elements of Physics; or, Natural Philosophy. Written for general use in untechnical language. By Neil Arnott, M.D., F.R.S. Part. II.

Brande and Cox's Dictionary of Science, Literature, and Art.

From *Mr. Van Voorst*:—

British Conchology; or, an Account of the Mollusca which now Inhabit the British Isles and the Surrounding Seas. Vol. III. Marine Shells. By John Gwyn Jeffreys, F.R.S., F.G.S. 8 Plates. 396 pp. Post 8vo.

From *Mr. R. Hardwicke*:—

On Letters Patent for Inventions. By Frederick Edwards, jun. 94 pp. 8vo.

From *Mr. C. F. Winter. Leipzig and Heidelberg*:—

Supplement zur Klimatographischen Uebersicht der Erde. Mit einem Appendix, enthaltend Untersuchungen über das Wind System und eine kartliche Darstellung des Systems der Erd-Meteoration. Von Adolf Mühry, M.D. With Charts and Engravings. 328 pp. 8vo.

From *Messrs. Bagster & Sons*:—

The Physical History of the Earth. Meditations by a Student. 134 pp. Fcap. 8vo.

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